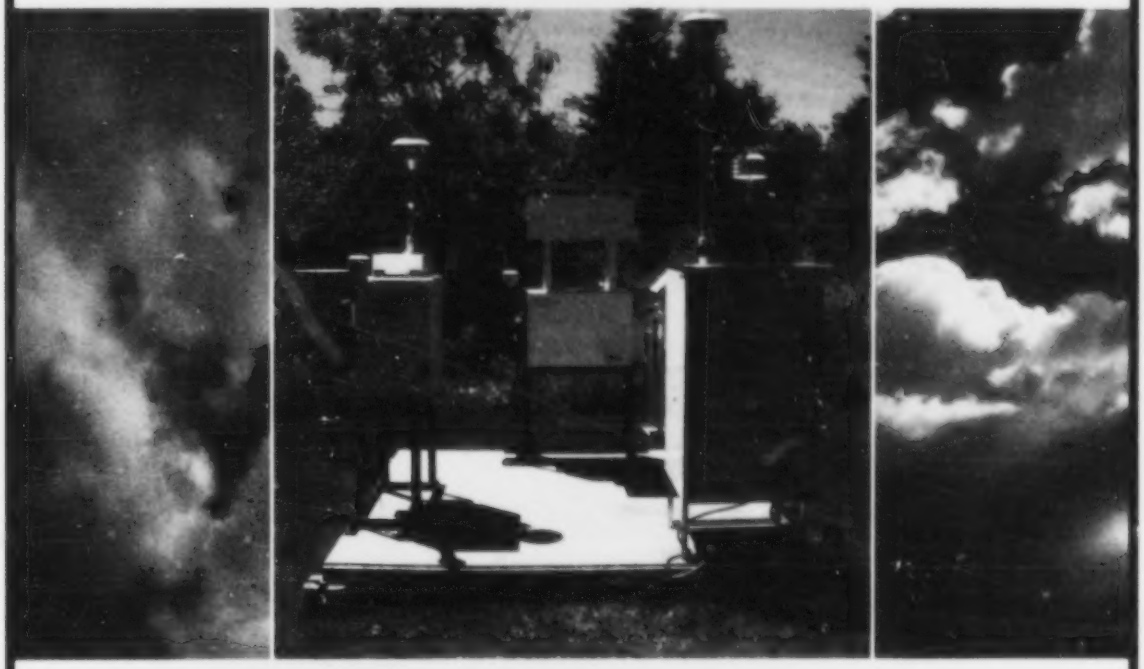
A REPORT ON

AIR QUALITY MONITORING RESULTS IN NEW BRUNSWICK

FOR THE YEAR 2003



Environmental Reporting Series

New Nouveau Brunswick
Environment and Local Government

2003 Air Quality Report
Corrections

Please note the following corrections in the report.

1. The upper table on page 20 should be replaced with the following table.

Exceedences of the 1-hour sulphur dioxide standard in 2003
Saint John (number of hours)

Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Forest Hills							1						1
Champlain Hts			1										1
Hillcrest													0
Customs													0
Three Mile													0
Forest Products							2						2
Silver Falls			1	1			4	1	2	1			10
Paper Mill Pump			21	18	31	19	1	8	1	10	32	10	153
Mobile Unit													0
Total			23	19	31	19	8	9	3	11	32	10	167

2. In Appendix II, page 83, the annotation on all four charts should read "1 hour standard is 170 ppb"

105-03088/

New Brunswick Department of the Environment
and Local Government

New Nouveau Brunswick

NEW BRUNSWICK

AIR QUALITY MONITORING RESULTS

FOR THE YEAR

2003

Technical Report T-2004-04

Sciences and Reporting Branch
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and Local Government
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December 2004

EXECUTIVE SUMMARY

This report summarises air quality monitoring data in New Brunswick for 2003. The report is intended to provide a convenient summary of air quality results for general public information, with emphasis on air quality assessment in relation to existing air quality standards and objectives. Long-term trend data are also presented for representative sites. In New Brunswick, air quality objectives are established for carbon monoxide, sulphur dioxide, hydrogen sulphide, nitrogen dioxide and total suspended particulate.

Air quality has been monitored in New Brunswick since the 1960s, when several short-term studies were carried out in Saint John. The emphasis on air monitoring has steadily increased over the years. Air contaminants presently covered by provincial objectives were measured at 53 sites in 8 regional monitoring networks across the province during 2003. Acid rain was measured at 13 additional sites. Inhalable particulate matter (PM_{10}), volatile organic compounds (VOCs) and mercury in air and precipitation were also monitored at some locations, although no standards were in effect in New Brunswick for these substances in 2003.

This report presents summary statistics from all monitoring sites in the province, with additional statistical data (in chart form) in an Appendix. Details are also provided on the quality assurance procedures used in the provincial air quality system.

During 2003 there were no exceedances of objectives for nitrogen dioxide or carbon monoxide at any of the provincial monitoring sites (nine sites for nitrogen dioxide and three for carbon monoxide). Exceedances for sulphur dioxide were higher in Saint John than in 2002, and showed little change in other networks. Ozone exceedances were similar to those in 2002. Elevated values of total reduced sulphur were less frequent in Saint John in 2003 compared to 2002, but more frequent in Miramichi. For particulate matter, there were no exceedances for PM_{10} in Saint John. For $PM_{2.5}$, there was a greater number of days having values in excess of the Canada-wide Standard than in 2002, primarily due to two regional haze episodes that affected the province during the summer months.

An examination of air quality trends at sites with long records indicates that since the late 1970s and 1980s, air quality has improved for all pollutants currently being measured, with the possible exception of ground level ozone, for which no clear trend is apparent. Levels of sulphur dioxide, total suspended particulate, and PM_{10} have fallen significantly over the past 15-20 years. Levels of carbon monoxide and nitrogen dioxide have also generally fallen. Total VOC and MTBE concentrations in 2003 increased at both Forest Hills and Champlain Heights, compared with 2002.

Although acid deposition has generally declined since the early 1990s, acid rain impacts continue to be of concern in the province, particularly in south-western districts. Sulphate in precipitation, a key indicator of acid rain, continued to decline in 2003, and was the lowest province-wide since 1986.

In 2003 the annual average concentration of mercury in precipitation at the St Andrews monitoring site was higher than in 2002, but lower than seen in the previous 6 years. There is little evidence of any trend for mercury in ambient air over the same time period.

During 2003, NBDELG continued to use its mobile air quality monitoring vehicle. The unit was sited in Saint John from February to May and Lamèque, in the Acadian Peninsula, from June to October, to investigate conditions in locations not covered by permanent monitoring sites. Notable results included no exceedances of standards at the Saint John location, and numerous elevated values of total reduced sulphur in Lamèque.

The management of air quality in New Brunswick is based upon the principles set out in the *Clean Air Act*. The Department's goal is full compliance with regulatory standards, and the prevention of degradation of air quality in the province.

Feedback

We are interested in your opinions and feedback on this report. All suggestions will be considered, and if possible, incorporated in future reports. You may contact the Sciences and Reporting Branch at (506) 457-4844, by fax at (506) 453-2265 or e-mail Robert Hughes at robert.hughes@gnb.ca with any comments.

Acknowledgements

Numerous staff within DELG and from the industries operating monitoring networks provided valuable help with data provision. Special thanks to Stan Howe and Eric Blanchard of DELG for operation of the provincial monitoring sites, and the staff of the Saint John regional office of NBDELG for assistance with site operation in the Saint John area. Thanks to Sean Fortune and Mallory Gilliss for operation of the acid rain network and assistance with emissions data. Thanks also to Karen Pelletier of NB Power for her help with the acid deposition network.

Thanks to Randy Piercey, Sean Fortune, Darryl Pupek, Don Murray, Mike Cormier, Matthew Dickson, Elizabeth Hayward and Don Grass for reviewing the report, and to Matthew Dickson and Erin Foster for help with data analysis, layout and production.

Thanks are also extended to site operators in the provincial acid rain monitoring network, including Alphonse Boissoneault (St. Maure), Marielle Morissette (Canterbury), Marie-Jeanne Cormier (Paquetville), Daniel Boudreau (Robertville), Jeffrey Suttie (Pennfield), Robbie Parish (Nictau), Murray MacFarlane (Holtville), Wanda and Bart Petley (Harcourt), Lori Lawlor (Lakewood Heights), Mae Stewart (Trout Brook), Gary and Nancy Kierstead (Coles Island), Luanne Brawn, Markle Brawn, Glen Eastwood, Robin Mazerolle, (South Oromocto Lake) and Thane Watts (Fundy Park).

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1. INTRODUCTION

This report summarises air quality information gathered during 2003 at monitoring locations across New Brunswick. A summary of data from the provincial acid rain network is also included. This report focuses on ambient (i.e. outdoor) air, which provides an indication of environmental quality in terms of air pollution. Some basic information on the emission of air contaminants is contained in section 9.

Air quality has been monitored in New Brunswick since the 1960s, when several short-term studies were carried out. A number of federal and provincial agencies were involved in these co-operative projects, including the N.B. Department of Health. The New Brunswick Department of the Environment was established in 1971. Following this, more routine air quality monitoring began in areas known to be affected by industrial emissions. The accompanying box details a number of significant events in the history of air quality assessment in the Province.

In 1973 the permitting provisions of the first *Air Quality Regulation* took effect, whereby facilities releasing contaminants to the environment could do so only in accordance with terms set out in an Approval to Operate.

By the late 1970s, emphasis was also being placed on providing air quality monitoring

AIR QUALITY MILESTONES IN NEW BRUNSWICK 1961-1980

DATE	EVENT
1961	Smoke and hydrogen sulphide monitoring carried out in Saint John by Transport Canada.
1964	Particulate pollution in Saint John studied by the Department of National Health and Welfare.
1970	Saint John District Medical Health Officer (DMHO) requested a federal study on air quality in the city.
1970	Dustfall and sulphur dioxide assessment began around the Belledune lead-zinc smelter.
1971	A five-week study of hydrogen sulphide, particulates and sulphur dioxide carried out in Saint John in response to the request of the DMHO.
1971	New Brunswick Department of Fisheries and Environment formed.
1971	Environment Canada, the federal environmental protection agency, established. The National Air Pollution Surveillance Network begins operation.
1971	New Brunswick Clean Environment Act entered force. National Air Quality Objectives proposed.
1973	The first provincial Air Quality Regulation enacted, including smoke density standards, a permit process for operations emitting air pollution, and limits on the sulphur content of fuel oils.
1974	Two-way catalytic converters required for new motor vehicles, to control carbon monoxide and hydrocarbon emissions.
1975	Extensive vegetation injury from air pollution seen in Saint John in July. Monitoring networks reviewed and improved.
1976	A computerised data collection system set up to gather data from air pollution monitors in Saint John.
1978	Air quality monitoring initiated around the Dalhousie thermal generating station.
1979	The issuing of a twice-daily air quality index system (Index of the Quality of the Air, or IQUA) began in Saint John.
1979	The Air Quality Regulation revised, with the inclusion of ambient air quality standards for the first time.
1980	The IQUA index reached the very poor range during a serious episode in Saint John in late July and early August, featuring high levels of sulphur dioxide and ozone.
1980	Air quality monitoring started in Edmundston to assess the impact of the Fraser pulp mill.

information to the public. In 1979, an air quality index for public information was introduced in Saint John. The "IQUA" program - (Index of the Quality of the Air) was the first program of its kind to be operated in any Canadian municipality.

AIR QUALITY MILESTONES IN NEW BRUNSWICK 1987-2001	
DATE	EVENT
1987	Three-way catalytic converters required on new motor vehicles, which reduce emissions of nitrogen oxides, as well as carbon monoxide and hydrocarbons.
1987	New Brunswick signs acid rain reduction agreement with Federal Government.
1988	Air quality monitoring established around the Grand Lake thermal generating station.
1989	Monitoring begun in Miramichi around the REPAP paper mill (then the MPPC mill).
1990	Leaded gasoline banned.
1991	Air quality monitoring started around the thermal generating station at Millbank and future site at Belledune.
1993	The provincial Clean Air Strategy released, outlining long term plans for air quality protection, enhancement and management.
1993	The smog advisory program (joint program with Environment Canada) began in southern counties of NB, providing public forecasts of high ozone levels.
1995	Air Resource Management Area (ARMA) Committee established in Saint John. The sulphur dioxide standard in Saint John, Kings and Charlotte counties reduced by 50%.
1996	ARMA committees established in Edmundston and Bathurst.
1997	ARMA committees set up in Dalhousie/Campbellton and Miramichi. Clean Air Act received government assent.
1997	IQUA issued in Saint John three times daily and available on the Internet. Daily forecasts of ground-level ozone released to the media for Fundy counties of southern New Brunswick (joint program with Environment Canada).
1997	Clean Air Act came into force on December 15.
1998	Air quality monitoring site established in Moncton.
1999	IQUA index available hourly via dial-in phone service in Moncton, Saint John and Fredericton. Daily ozone forecasting expanded to central and eastern New Brunswick.
2000	Daily ozone forecasts issued province wide from May to October (joint program with Environment Canada).
2001	Mobile air quality unit brought into use.

2. AIR QUALITY LEGISLATION IN NEW BRUNSWICK

The basic framework for air quality management in New Brunswick is provided by the 1997 *Clean Air Act*. This Act broadly specifies the areas and activities in which the Minister of the Environment and Local Government has authority to make regulations.

In comparison to the *Clean Environment Act*, the *Clean Air Act* is more comprehensive and detailed legislation. It also places major emphasis on providing information to the public and encouraging opportunities for public involvement in decision-making.

Regulations are created under such Acts in accordance with the authority they provide, and set out the detailed requirements which must be followed by individuals or organisations that are subject to the legislation.

Since 1973, the *Air Quality Regulation* has been the Province's principal regulatory tool in this field and, with some recent revisions, it continues to apply under the *Clean Air Act*. It sets out detailed requirements and provisions for a wide range of air quality management issues. Provincial air quality standards have also been contained in this regulation since 1979.

Other regulations which are used to manage air quality cover issues such as Ozone Depleting Substances. As part of the more comprehensive *Clean Air Act*, additional regulations have been prepared, including the *Administrative Penalties Regulation* (which came into force in July 1998) and the *Public Participation Regulation* (which entered force in March, 2002).

These regulations are aimed at providing the Province with additional options to promote compliance, and formalising procedures for public review of Certificates of Approval for major emission sources, as well as the process of setting or revising air quality objectives for the Province.

The *Clean Air Act* and its associated regulations are intended for the management of outdoor air quality. Air quality in buildings is regulated by health legislation, including the *Health Act* and the *Occupational Health and Safety Act*.

3. NATIONAL AIR QUALITY STANDARDS AND OBJECTIVES

Air quality management in Canada is primarily a provincial responsibility, although the Federal Government has a key mandate to carry out monitoring and research, as well as to manage air issues which have a trans-boundary or international component. An example is the long-range movement of air pollutants across provincial or international boundaries, such as those that cause acidic precipitation and ground level ozone.

Canadian air quality objectives are developed by a national committee (the Working Group on Air Quality Objectives and Guidelines), which includes representation from federal and provincial health and environment officials. When finalised through the Working Group process, the resulting "National Ambient Air Quality Objectives" are incorporated in federal legislation under the *Canadian Environmental Protection Act*.

The goal of this process is to ensure some degree of uniformity across the country. Provinces then have the opportunity to incorporate these national objectives in their own environmental legislation. A complete listing of Canada's existing National Air Quality Objectives is contained in Appendix I.

National Objectives cover the major air pollutants of concern. Individual provinces, however, are able to develop additional air quality objectives or guidelines, if deemed necessary for environmental management in their particular jurisdiction. An example of this would be New Brunswick's decision in 1995 to adopt ambient air quality standards for sulphur dioxide (SO_2) in the southern part of the Province which are twice as stringent as the existing National Objectives for this substance.

The National Working Group on Air Quality Objectives and Guidelines periodically reviews the latest scientific work dealing with the effects of pollutants on human health, and the environment in general. Based on these reviews, the existing National Air Quality Objectives are revised as required. New objectives may also be proposed.

With the exception of the objective for ground level ozone, New Brunswick has included all National Air Quality Objectives in its *Air Quality Regulation* since 1979. This action has the effect of giving such objectives legal status through the *Air Quality Regulation's* approval process.

In the case of pollutants such as ground level ozone, the management approach in New Brunswick involves reducing the precursor emissions wherever possible, together with concerted regional control efforts, since the majority of ground level ozone measured in

New Brunswick originates in the north-eastern United States and, to a lesser extent, southern Ontario and Quebec. This involves federally-led negotiations with States and Provinces which lie upwind from our western border. Precursor emissions are the substances that eventually lead to the formation of the pollutants themselves. For example, ground level ozone results from photochemical reactions in the air involving NOx (nitrogen oxides) and VOCs. In this case, NO_x and VOCs are precursors.

Canada-wide Standards

The most recent environmental standard-setting exercise across the country is an initiative managed by the CCME (Canadian Council of Ministers of the Environment). The standards being established in this process are termed "Canada-wide Standards". Canada-wide Standards (CWS) are being established for air, water, soils and sediments. The focus is on setting environmental quality standards which are based on sound science, with the aid of stakeholder public input. Other aspects of the CWS process include a consideration of socio-economic and technical issues as the standards are determined, the development of an implementation plan for each standard, and a commitment for public reporting on the achievement of the standards. More information and updates are available at: http://www.ccme.ca/initiatives/standards.html.

Canada-wide Standards in New Brunswick

New Brunswick is a signatory to the *Canada-wide Accord on Environmental Harmonization*, the broad agreement under which Canada-wide Standards have been developed, and the *Canada-Wide Environmental Standards Sub-Agreement*, which deals specifically with standards. Provinces in turn may formally agree to each individual CWS. In 2001, New Brunswick signed the Canada-wide standards for $PM_{2.5}$ and ozone, which commits the province to a variety of actions, aimed at achieving compliance with these standards by 2010. These actions include a variety of emission control measures, plans for protecting existing "clean" areas, and the use of standard methods for monitoring and reporting. Extensive supporting documentation can be found on the CCME web site at: http://www.ccme.ca/initiatives/standards.html?category_id=5.

4. NEW BRUNSWICK AIR QUALITY OBJECTIVES

In March 2002, New Brunswick's air quality guidelines for carbon monoxide, nitrogen dioxide, sulphur dioxide, total suspended particulates and hydrogen sulphide, specified in the *Air Quality Regulation*, were officially established as "air quality objectives" under the *Clean Air Act*. This action ensures that other provisions of the Act take effect, in particular the requirement to report annually to the Legislative Assembly on the achievement of air quality objectives, as noted in section 9 of the Act. For reference, the air quality objectives are given in the following table. The Order establishing the objectives may be found on the DELG web site at: http://www.gnb.ca/0009/0355/0005/0030-e.html.

Note that the Order Establishing Objectives defines concentrations in units of micrograms per cubic metre. It is common working practice in air quality reporting to use units of parts per million or billion for gases, hence data in the table have been converted to these units, where applicable (using standard conditions of 294K, 101.3 kPa).

NEW BRUNSWICK AIR QUALITY OBJECTIVES

Pollutant	Averaging period			
	1 hour	8 hour	24 hour	1 year
Carbon monoxide	30 ppm	13 ppm		
Hydrogen Sulphide	11 ppb		3.5 ppb	
Nitrogen dioxide	210 ppb		105 ppb	52 ppb
Sulphur dioxide*	339 ppb		113 ppb	23 ppb
Total suspended particulate			120 micrograms/m^3	70 micrograms/m^3

* The standards for sulphur dioxide are 50% lower in Saint John, Charlotte and Kings counties.

5. OTHER AMBIENT AIR QUALITY CRITERIA

A. PM_{10}

There is presently no National Objective for PM_{10} in Canada, although this is under consideration. Some existing standards in other areas are shown in the following table. These standards (primarily those from the Greater Vancouver Regional District and the U.S.A.) are currently used as reference points for evaluation of any PM_{10} data gathered in NB.

PM_{10} Standards in Various Jurisdictions (micrograms per cubic metre)

Jurisdiction (date)	Averaging period	
	24-hour	1 year
GVRD (Vancouver) (1994)	50	30
Newfoundland (1997)	50	-
United States (1987; revised 1997)	150	50
California (1982, 24-h; 2002, annual)	50	20 (2002)
Australia (1998)	50	-

B. $PM_{2.5}$

The following table lists some standards or objectives currently in place or being phased in around the world for $PM_{2.5}$. Standards for $PM_{2.5}$ continue to evolve in a variety of forms in different countries. The more recently enacted standards have tended to be more stringent.

$PM_{2.5}$ Standards in Various Jurisdictions (micrograms per cubic metre)

Jurisdiction (date)	Averaging period		Details
	24-hour	Annual	
United States (1997)	65	15	98th percentile, 3-year average for 24-h standard. Under review.
California (2002)	25 (proposed)	12 (enacted)	
Newfoundland (1997)	25	-	
Canada (2001) (Canada-wide Standard)	30	-	98th percentile, 3-year average. Compliance by 2010
Australia (2003)	25	8	"Advisory reporting standard"

C. Ground Level Ozone

As with PM_{10}, there is no New Brunswick objective in effect for ground level ozone. For evaluation purposes, the existing National Objectives for ozone are used as a reference and are shown in the following table. Additional information on the National Air Quality Objectives is contained in Appendix I. Note that New Brunswick is participating in the implementation of Canada-wide standards for both $PM_{2.5}$ and ozone. In addition, New Brunswick provided input for the development of an Ozone Annex to the Canada-US Air Quality Agreement, signed in December 2000. The Annex formally recognises the geographic regions in Canada and the US where specific control measures must be applied to reduce ozone formation. It also deals with emission caps or ceilings; technical limits on certain industrial processes; scientific work such as data sharing, mapping and interpretation, and data reporting.

National Ambient Air Quality Objectives for Ozone (ppb)			
Averaging period	Desirable Level	Acceptable Level	Tolerable Level
1 Hour	51	82	153
24 hours	15	25	-
Annual	-	15	-

Note: for an explanation of the different levels, see Appendix I.

6. AIR POLLUTANTS - THEIR SOURCES AND EFFECTS

Basic information is presented in the following sections about the pollutants covered by regulatory ambient objectives in New Brunswick. The sources of such pollutants are also discussed, as well as their effects on human health and the environment.

A. Carbon Monoxide

Carbon monoxide (CO) is a colourless, odourless and tasteless gas. Major sources include motor vehicles, home heating systems, and refuse burning. Outdoors, CO is generally a problem pollutant only in congested urban centres with high traffic density, especially in winter, as vehicle engines produce more pollution in cold weather. In some traffic conditions, drivers and passengers in vehicles may be exposed to higher levels of CO than pedestrians in city streets. Malfunctioning or badly-vented heating furnaces, gas cooking stoves or woodstoves may also produce dangerous levels of CO in buildings. Other environments with an above-average risk of elevated CO levels include ice skating rinks, parking garages and traffic tunnels (WHO, 1999).

Background concentrations of CO in remote parts of the Northern hemisphere are around 0.1 ppm (WHO, 1999). Average annual concentrations in centres across Canada range from 0.5 to 1.0 ppm (Environment Canada, 2002).

If inhaled, CO quickly enters the blood stream, where it reduces the ability of the blood to deliver oxygen to the organs and tissues of the body. The health impact of CO is most serious for those who suffer from cardiovascular disease, although healthy individuals are also affected at higher concentrations. Exposure to elevated levels is associated with numerous symptoms, including headache, fatigue, confusion, nausea, and impairment of vision. Work capacity, learning ability and the ability to perform complex tasks are reduced (Stewart, 1975; USEPA, 1980; Ritchie, 1991; CEPA/FPAC Working Group on Air Quality Objectives and Guidelines, 1994; 1998; WHO, 1999).

B. Nitrogen Dioxide

Nitrogen dioxide (NO_2) in high concentrations is a reddish gas with a sharp, pungent smell. It is corrosive and can assist the start and spread of fire. Most NO_2 found in the outdoor environment is not the result of direct emissions. Instead, it forms from nitric oxide (NO), which is emitted by many combustion sources, especially those which operate at high temperatures and pressures.

Motor vehicle engines meet both these characteristics, and are a major source of NO, which reacts quite rapidly with ozone in the air to form NO_2. Collectively, NO and NO_2 are often referred to as nitrogen oxides or NO_x. Thermal electricity generating stations and large heating boilers are other major sources of NO_x.

Nitrogen dioxide can irritate the lungs and lower resistance to respiratory infection. It can also provoke cardiac arrhythmias and cause a range of respiratory symptoms (e.g. Frampton, 2002). It also has an adverse effect on materials (e.g. corrosion of metals, fading of fabric dyes, degradation of rubber, etc.) and can damage vegetation (CEPA/FPAC Working Group on Air Quality Objectives and Guidelines, 1987a).

As noted earlier, NO_2 also plays an important role in the formation of ground-level ozone, by reacting with hydrocarbons in the presence of sunlight, and contributes to the formation of acid rain and visibility-reducing haze, or smog.

C. Sulphur Dioxide

Sulphur dioxide (SO_2) is a colourless gas with a characteristic smell, like that of a struck match. When levels reach between 0.3 to 1.0 parts per million (ppm), it is generally detectable as an acidic taste in the air. SO_2 dissolves very readily in water, eventually forming sulphuric acid. SO_2 is one of the most significant pollutants in many industrialised nations: it is often emitted as a result of burning sulphur-containing fuels, and by metal smelters and oil refineries. Emissions of SO_2 from motor vehicles are relatively minor.

Health effects associated with exposure to high concentrations of sulphur dioxide include breathing discomfort, respiratory illness, alterations in the lungs' normal defences, and aggravation of existing respiratory and cardiovascular disease. People with asthma, chronic lung or heart disease are the most sensitive to SO_2. Apart from effects on human health, SO_2 can also directly damage the leaves of trees, and agricultural crops. (Environment Canada, 1985; CEPA/FPAC Working Group on Air Quality Objectives and Guidelines, 1987b). SO_2 also has important indirect impacts by contributing to acid rain, which acidifies lakes and rivers, speeds up the corrosion of masonry and metal objects, and removes essential elements from the soil. Sulphur dioxide also contributes to the formation of acid aerosols (fine acidic particles), which may have detrimental health effects. These small particles cause a visual

haze, which affects the enjoyment of scenic vistas and has an effect on the earth's radiation balance.

D. Hydrogen Sulphide

Hydrogen sulphide (H_2S) is a colourless gas with a characteristic smell of rotten eggs. H_2S is flammable and can form an explosive mixture with air or oxygen. Common sources of H_2S include pulp and paper mills, oil refineries, steel processing plants, natural gas plants, and sewage treatment systems. Natural sources include sulphurous hot springs and volcanic vents, swamps and bogs. Naturally-occurring sulphate-reducing bacteria can also produce H_2S in domestic water systems. The processes which produce hydrogen sulphide often generate other sulphur-containing compounds, such as methyl mercaptan and dimethylsulphide. These substances are also highly malodorous, and are often grouped together with hydrogen sulphide and referred to as total reduced sulphur compounds, or TRS.

In the ambient air, the undesirable effects of H_2S are generally felt in terms of a bad odour. The odour threshold for H_2S is generally 1-5 ppb, but can be lower for some individuals. Background concentrations in unpolluted areas are around 0.1 ppb (WHO, 2003). There is some evidence that persistent exposure to unpleasant odours may have a significant effect on community health: review and monitoring of relevant health studies continues (e.g. Kilburn, 1997, 1999). There is also evidence that H_2S can contribute to an increased rate of spontaneous abortions when annual concentrations exceed approximately 3 ppb (WHO, 2003).

At higher concentrations (from 2 to approximately 100 ppm) hydrogen sulphide affects the mucous membranes, causing eye and throat irritation. Above this level H_2S becomes life-threatening as the sense of smell is impaired, removing the body's normal warning signal.

High concentrations of hydrogen sulphide can also cause paint discoloration and metal corrosion, and are damaging to plants (Environment Canada, 1984; Masters, 1997). Life-threatening levels, in excess of 300 ppm, can exist in underground sewer pipe systems and occasionally above ground near sewer manholes, in situations where sewer gases are released from underground piping. During drilling for oil and gas, blow-outs can also occur with the release of large quantities of H_2S.

Ambient concentrations in New Brunswick, even in the vicinity of large emission sources, seldom exceed 40 ppb (0.04 ppm).

Total Reduced Sulphur

Total Reduced Sulphur (TRS) is a family of odourous compounds including hydrogen sulphide, methyl sulphide, dimethyl sulphide and dimethyl disulphide. Some common sources of TRS include petroleum refineries, storage tanks for unrefined petroleum products, natural gas plants, petrochemical plants, sewage treatment facilities, and pulp and paper plants that use the kraft pulping process, Monitoring in the vicinity of Kraft pulp mills in New Brunswick generally includes TRS. When evaluating monitoring data for TRS, reference may be made to standards or objectives for hydrogen sulphide. Although hydrogen sulphide may be a major component of TRS, the exact proportion is not known unless specific analysis for both H_2S and TRS is performed.

E. Ground-Level Ozone

Ozone (O_3) is a reactive, unstable form of oxygen. In very high concentrations, it is a bluish gas. The characteristic sharp smell of ozone may be recognised around electrical

equipment such as motors or arc welders, where it is formed by the high temperature electric spark. In the concentrations found in outdoor air, even in the most severe pollution episodes, ozone is both colourless and odourless. Ozone is not emitted directly from smokestacks and exhaust pipes, but is formed in the air from other pollutants, most importantly nitrogen oxides (NO_2) and hydrocarbons or VOCs (such as solvent and gasoline vapours).

Vehicle exhaust contains all the necessary compounds to produce ozone, and, as a result, cars and trucks are important contributors to ground level ozone concentrations. Industrial emissions of NO_x and hydrocarbons are also significant precursor emissions for ground level ozone.

Slow-moving air and strong sunshine greatly speed up the formation of ozone. As a result, ground level ozone is not typically a problem pollutant in the cooler months, but is likely to be more significant in hot, hazy summer weather. Such haze may build up over a period of days into a "photochemical smog". However, the yellow or brownish colour of such smog is usually due to nitrogen dioxide and fine chemical particles, not the ground level ozone itself.

Because the formation of ground level ozone depends on weather conditions, the severity of ozone pollution can be very variable from one year to the next. In New Brunswick, significant ozone episodes occur on average about six times per summer, mainly affecting the southern part of the province. Much of this ozone originates from populated regions of the north-eastern United States, especially the Washington to Boston "corridor".

Ground-level ozone irritates the lungs, causing airway inflammation, and can make breathing difficult. Exposure to high concentrations can result in chest tightness, shortness of breath, reduced lung capacity and exercise performance, and coughing and wheezing. Recent health research suggests there is no clear "safe" threshold for ozone. Asthmatics appear to be more sensitive to repeat ozone exposures than healthy subjects. Concentrations as low as 60 ppb cause a measurable reduction in exercise performance. There appears to be an additive or synergistic effect between ozone and some other principal air pollutants such as SO_2 and NO_2 (Health Canada, 1999). Ground level ozone can cause damage to agricultural crops which are ozone-sensitive, such as potatoes and tomatoes. It can also cause noticeable leaf damage in other species. Forest trees and other vegetation may be injured, or growth inhibited. Ozone also weakens rubber, and attacks metals and painted surfaces (Bates, 1980; Multistakeholder NOx/VOC Science Program, 1997c).

Ozone levels are often lower in city centres than in surrounding rural areas. This is because ozone reacts with nitrogen oxides, often found in relatively high concentrations in city cores due to emissions from motor vehicles. This effect is seen in Saint John, although to a lesser extent than in larger cities. A separate network of sites exists to assess rural ozone. The results from that network are discussed later in this report (section 11).

F. Total Suspended Particulate (TSP)

Particles in the air (also called "particulates" by air pollution scientists) may either be of natural origin or the result of human activity. Some common natural sources and types of particulates include wind-blown soil dust, forest fires, sea salt, volcanoes, and plants (which produce pollen and spores). Human activities which generate particles include fuel combustion (domestic and industrial) and any other burning (e.g. waste incineration or

slash burning); travel on dirt roads, construction work, and mining and quarrying. Dust on road and work sites is often wetted down to control particulate emissions. Other kinds of particles form in the air when gases such as sulphur dioxide (SO_2) and nitrogen oxides (NO_x) react together. These particles are partly responsible for the yellowish "smog" sometimes seen over large cities.

"Total suspended particulate" (TSP) has been a standard pollution measurement for many years, obtained by drawing a large volume of air through a special filter. This method makes no distinction between natural particles, such as pollen and spores, and particles which are emitted from vehicles or smokestacks.

People with existing breathing complaints such as asthma, bronchitis or emphysema, are liable to be adversely affected by high concentrations of particulates (Wilson and Spengler, 1996; CEPA/FPAC Working Group on Air Quality Objectives and Guidelines, 1998)

Particulates can also cause corrosion and soiling of metalwork or other materials, damage vegetation, and reduce visibility.

G. PM_{10}

Particles smaller than 10 microns (a micron is a millionth of a metre, or a thousandth of a millimetre) are called PM_{10}, and are not filtered out of the air by the nose, throat and upper windpipe. As a result, these very small particles can enter the lungs where they may irritate or otherwise have an adverse effect on the delicate membranes and air sacs which absorb oxygen. Other toxic effects may occur, depending on the chemical make up of the fine particles. Because they can enter the lungs, PM_{10} particles are sometimes referred to as 'inhalable' particles, and are measured separately from TSP.

A number of recently published health studies have concluded that lung function, cardio-respiratory mortality, respiratory illness-related hospital admissions, and a variety of other health factors are related to ambient concentrations of PM_{10}. However, which particular aspect of the fine particles is causing these effects has not yet been fully resolved. Particle chemistry, and possibly

TERMS USED TO DESCRIBE PARTICLES AND HAZE

TSP: Total suspended particulates. A measure of particle concentration determined with a high-volume air sampler, which draws air through a filter over a 24-hour period. Includes particles with a wide range of sizes, up to 25-45 microns in diameter. TSP is normally measured on a nationally-standardised one-in-six day cycle.

PM_{10}: Particulate matter with an effective diameter of 10 microns or less. Also termed "inhalable particulates", as particles of this size are small enough to be inhaled via the mouth and some may enter the lungs.

$PM_{2.5}$: Particulate matter with an effective diameter of 2.5 microns or less, which bypasses filtration in the nose and may be deposited in the lungs. Also referred to as "respirable" particulate.

CoH: Coefficient of Haze. A relative measure of particle concentration determined by drawing air through a paper tape and measuring the change in light transmission of the tape.

Particles, particulates, aerosols: When referring to air quality, these terms are interchangeable, and refer to particles small enough to be transported some distance through the air. Most of these are less than 40 microns in diameter (roughly the size of pollen grains).

Fine particles: Particles with an effective diameter between 0.01 and 2 microns. Most particles forming as a result of industrial processes and combustion (natural or man made) are in this size range. Sometimes loosely used to refer to $PM_{2.5}$. Includes smoke particles.

Coarse particles: Particles with an effective diameter between 2 and 100 microns; includes PM_{10}. Much of the coarse particle load in the atmosphere is of natural (crustal) origin. Also includes pollen and spores.

acidity, may be important. As for ozone, there appears to be no clearly defined "safe" threshold for PM_{10}, or $PM_{2.5}$ (see below).

Recent studies also suggest that particles have effects on the immune system (Wilson and Spengler, 1996; Blomberg, 1998). PM_{10} and $PM_{2.5}$ have been declared "toxic" under the Canadian Environmental Protection Act (Environment Canada, 2000). This means that these substances must undergo a detailed review and actions must be put in place to reduce their production and release into the environment.

In Canada, only the Greater Vancouver Regional District (GVRD) and the province of Newfoundland have a standard in place for PM_{10}, although work on developing a national objective is currently under way. In the United States, standards exist both nationally and in California, which has the same standard as the GVRD (see table on page 6).

H. $PM_{2.5}$

Another standard specification for measuring particulates is $PM_{2.5}$, which refers to particles equal to or smaller than 2.5 microns in size. These particles are thought to be of special significance in terms of health impacts, as they have a higher chance of entering and remaining in the lungs if inhaled, compared to PM_{10} or larger particles. They are sometimes referred to as 'respirable particles'.

Particulate matter in the $PM_{2.5}$ size range is emitted from industrial and domestic combustion sources including slash burning, industrial processes (e.g. power plants, pulp mills, mining, smelting, and refining), open fires, woodstoves, forest fires, and internal combustion engines of all kinds. $PM_{2.5}$ also forms when other air pollutants react together in the air. An important chemical reaction leading to the production of $PM_{2.5}$ is the combination of sulphur dioxide with ammonia, producing ammonium sulphate. Many other reactions are possible between natural atmospheric components and the air pollutants typically emitted in populated regions of North America and the world in general. Particles produced by this "gas-to particle conversion" are very small and contribute to haze over large areas.

Transportation, industrial and other fuel combustion account for about 25% of the $PM_{2.5}$ emitted to the air. The rest comes from so-called "open" sources, which include open burning, forest fires, road dust and construction (Environment Canada, 2003). The estimated emissions from road dust and forest fires are very large, and dominate the inventory. Emissions from some source sectors are of greater concern than others in terms of health and other environmental effects. Recent studies indicate that particulate from combustion sources is more "biologically active" than road or other dust from terrestrial sources. Diesel exhaust is of special concern as it is thought to contribute significantly to the risk of lung cancer (USEPA, 1999).

Numerous studies worldwide continue to find a significant association between $PM_{2.5}$ concentrations and a wide range of health effects, including premature mortality, many cardio-pulmonary symptoms, reduced activity, increased physician visits and other forms of disability (e.g. Goldberg et al., 2001; Stieb et al., 2002).

Monitoring technologies have been introduced in recent years which allow the continuous measurement of PM_{10} or $PM_{2.5}$. These units provide continuous, unattended recording and electronic logging and reporting functions. These units are now installed and operating in Saint John (two sites), Fredericton, Moncton, and St. Andrews. In June 2000 an additional monitor began operation in Edmundston, maintained

by Fraser Paper Inc. Two further continuous $PM_{2.5}$ monitoring units are being deployed in Miramichi by the Weyerhaeuser company and became operational during 2003.

I. Volatile Organic Compounds

VOCs are carbon-containing substances which are present in the air in gas form, usually at low concentrations (in the parts per billion range). Used in the context of air quality, VOCs are substances which often evaporate readily.

Thousands of different VOCs exist in the air. However, many VOCs are of natural origin, and in terms of environmental protection, the VOCs which cause some kind of problem are most important. Everyday examples of VOCs which may be a concern in the environment include gasoline and organic solvents. Other products such as paint, adhesives, and a variety of other household goods may contain solvents which evaporate and contribute to the VOC content of the air. VOCs are also emitted by a wide range of industrial sources, as well as by motor vehicles. Vehicles emit VOCs in their exhaust, and from fuel tanks. Modern vehicles have systems in place to minimize such emissions, but overall, transport-related emissions are still substantial. A large number of VOCs can be emitted by industrial processes (for example by the petrochemicals or plastics industries).

Some VOCs may be potentially toxic to humans, animals or vegetation (e.g. benzene, 1,3 butadiene, ethylene) or are of concern because they can react in the air to form other harmful substances. For example, ethylene and propylene (and many other VOCs) may take part in reactions which lead to the formation of ozone-containing smog. Some VOCs,such as various petroleum hydrocarbons, may contribute to undesirable odours.

The VOC sampling program in New Brunswick concentrates on about 150 compounds which are of special interest, including known and suspected carcinogens such as benzene and 1,3 butadiene, and photochemically active VOCs which contribute to smog formation.

7. CLIMATIC CHANGE AND AIR QUALITY

Weather has a significant influence on air quality. Any progressive change in weather patterns due to climatic change would be expected to affect air quality as well. Such changes could result from alterations in pollutant transport, if wind patterns change. In addition, chemical processes in the atmosphere may alter. For example, ground level ozone would be expected to increase, given higher summer temperatures. There is a strong link between hotter days and higher ozone concentrations. The chemical reactions that produce ozone are faster at higher temperatures, and VOC emissions from man-made and natural sources also increase as the temperature rises.

Any change in the frequency of anticyclonic episodes (stable weather systems with light winds, which inhibit dispersion) would affect levels of all air pollutants, especially peak levels of particulate matter. Other indirect effects could also be expected. For example higher summer or lower winter temperatures result in greater fuel consumption for electricity generation and space heating and cooling, which in turn drives up the associated pollution emissions. On the other hand, if milder winters become more common, emissions linked with space heating would diminish. Climatic change could also affect the prevalence of airborne dust and allergens such as pollen and fungal spores, via changes in humidity, wind speed, cloudiness or the frequency of rain (e.g. Bernard, 2001).

At present, predicting how climatic change is likely to affect air quality in New Brunswick remains largely a matter of speculation. Existing modelling exercises to predict future climate in the region are relatively few, and their conclusions are subject to large uncertainties (e.g. Natural Resources Canada, 2002; Hengeveld, 1990). The spatial resolution of most climate models is coarse, typically using a grid with squares approximately 120,000 km^2 in area, or roughly twice the size of New Brunswick. Recent attempts to predict changes at the provincial scale (e.g. Swansburg , in press) suggest that by 2099, temperatures may increase by as much as 4-5°C, with precipitation increasing by 10-50%. The greater increases in precipitation are predicted for the north of the province. The forecasts for precipitation are more variable across the province, with some seasons showing little change in some areas, and other areas and seasons predicted to see significant increases. Notably, summer precipitation is predicted to remain fairly stable in central New Brunswick, the warmest part of the province. This, coupled with higher temperatures, is expected to reduce river discharge and overall water availability.

So what are the best predictions that we can make for the effect of climate change on air quality at present? Given that in the long term, the consensus prediction for the province is for increased temperatures, we can expect a tendency for higher concentrations of ground level ozone. Given that higher temperatures are often associated with periods of reduced dispersion, especially near the coast, it follows that the frequency of short-term episodes of reduced air quality would also increase. Such episodes may be characterised by elevated levels of industrial pollutants, such as sulphur dioxide or hydrogen sulphide, and particulate matter. These predictions are made assuming that emissions remain similar to the present day. In practice, further emission reductions may occur, which may offset some of the possible adverse influences of a warmer climate. Also, some effects of expected changes in climate may be positive.

8. MONITORING NETWORKS

Compliance with air quality objectives or regulatory standards is determined by monitoring. Because exposure to many air pollutants can occur at any time, most are monitored continuously, although particulates have been an exception. However, new technology now allows continuous measurement. As a result, continuous particulate measurements are gradually becoming more widespread and available.

Monitoring locations are selected so that they will provide information which is representative of the surrounding area. In cases where there is a known pollutant source, monitors are often distributed around it in locations where the impact is expected to be greatest. Such locations are typically selected based on the results of computer dispersion models. These are computer programs which simulate the behaviour of plumes, or discharge streams of gases as they are released from smokestacks. Such models take into account the complete variety of weather conditions which may be experienced in the area where the stack is located, as well as the nature of the local landscape.

In New Brunswick, large industrial emission sources, such as electricity generating stations or pulp mills, are legally required by DELG to carry out ambient air quality monitoring as prescribed in their Approvals to Operate under the Clean Air Act. Such Approval conditions also detail the required equipment specifications, locations and reporting frequency. In such cases, the monitoring equipment and maintenance

procedures are checked periodically by DELG staff or independent auditors, to ensure the required standards for operation and technical accuracy are being met.

In the case of air pollutants which are transported long distances, and which may be found in rural, as well as urban areas, DELG establishes and operates its own monitoring sites. The Department also maintains sites in areas where there are multiple large industrial emission sources, such as Greater Saint John. In addition to 13 provincial sites, there is one federally-operated acid rain monitoring site in New Brunswick (at Harcourt, in eastern New Brunswick). Federal support is also provided for the operation of several other air quality monitoring sites across the province (through the National Air Pollution Surveillance program).

The location of air quality monitoring sites and the main regional and local networks are shown on the following map (Figure 1). More detail on the exact location of each site is provided in the following sections.

The major industry or urban networks are identified. Filled circles on the map indicate rural ozone sites. The remainder indicate ambient monitoring locations for other substances including sulphur dioxide, nitrogen dioxide and particulates.

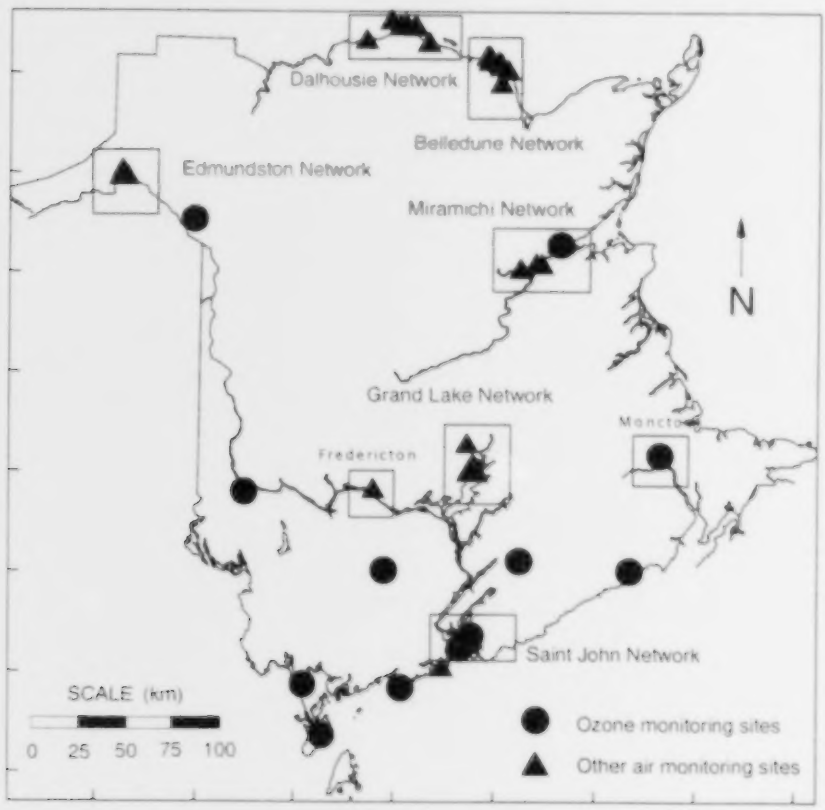


Figure 1. Locations of air quality monitoring sites in New Brunswick, 2003.

9. EMISSIONS OF AIR POLLUTANTS

A summary of emissions of the principal air pollutants in New Brunswick, and their source categories, is provided in this section.

Note that emissions from "open sources" such as dust from roads or smoke from forest fires, are not included.

Details are shown in the following pie charts (Figure 2).

The effects of air pollutants depend on many factors, including how they are released. This varies considerably, depending on the type of emission source. Vehicles emit their exhaust close to the ground. There are numerous individual vehicles (sources) which collectively spread their emissions over wide areas, such as within and downwind of urban centres. In contrast, large industries such as power generating stations, oil refineries, pulp mills and metal smelters usually have high chimney stacks. There may be variable local impacts, which can be relatively concentrated if the emission plume approaches or contacts the ground. The estimated total emission of particulate matter from roads (paved and unpaved) is very large. Again, this kind of emission takes place close to the ground; the dispersion behaviour will be very different from particulate emitted from a tall smoke stack. And whereas sulphur dioxide, whether emitted from a refinery, smelter, pulp mill or a vehicle, is still sulphur dioxide, the chemical makeup of particulate matter is highly variable depending on the source.

Further detail on pollutant emissions may be found at: http://www.ec.gc.ca/pdb/ape/

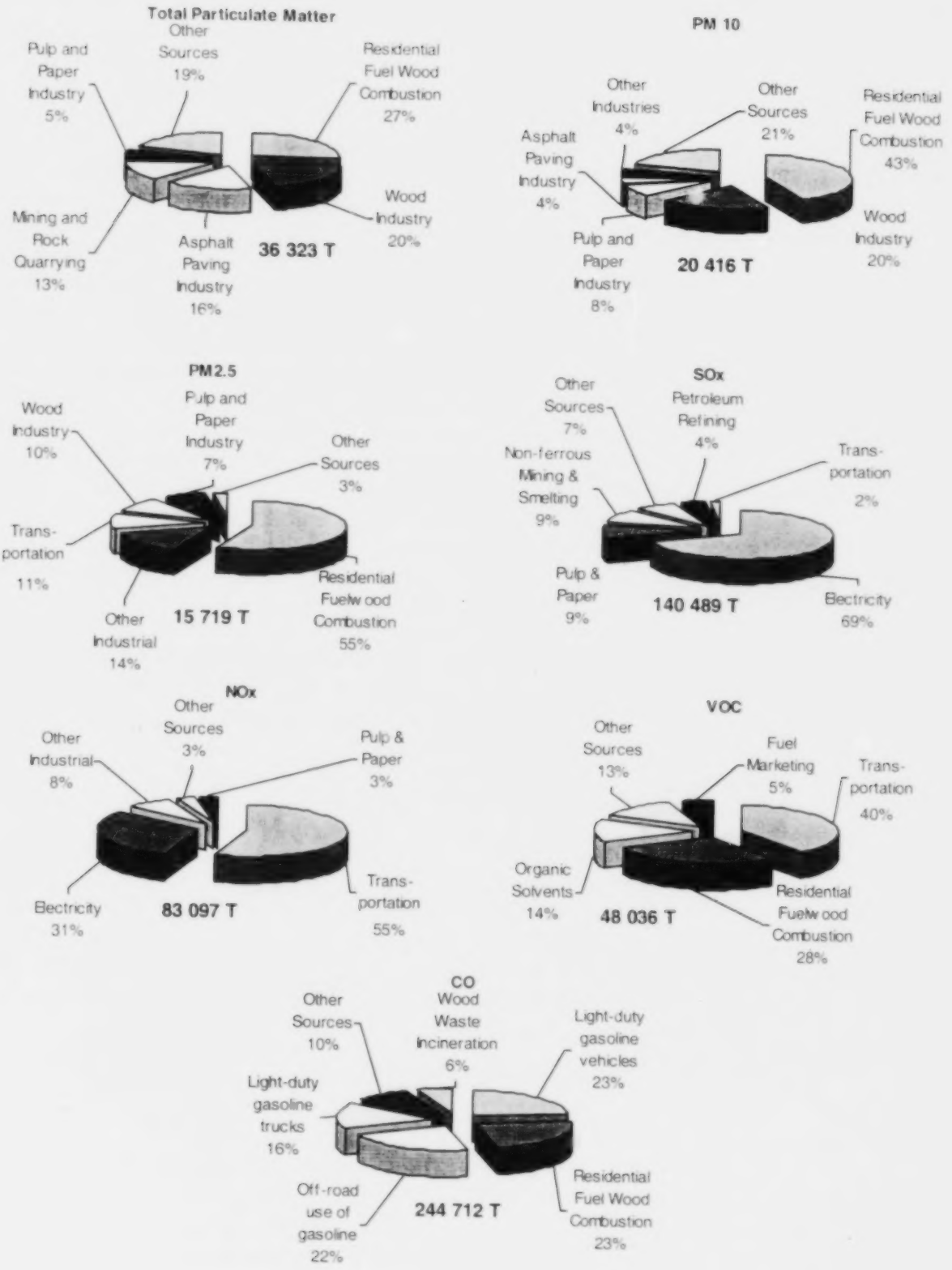


Figure 2. Emissions of principal air pollutants in New Brunswick (2000). T = tonnes.

10. AIR QUALITY MONITORING RESULTS FOR 2003

Results are presented for each monitoring network in the Province. The locations of the monitoring sites are shown on regional scale maps. The numeric results are shown in tables, and further details in chart form appear in Appendix II.

Explanatory notes are provided on each network, and a discussion of the results for each network is included.

A. SAINT JOHN

The Saint John area has the longest history of air quality monitoring in New Brunswick, beginning in 1961 (see boxes on pages 1-2). Since that time, air quality has been monitored at more than 30 different locations in the city and surrounding area. Air quality monitoring sites which were active in 2003 (a total of 13 separate locations) are shown on the following map (Figure 3).

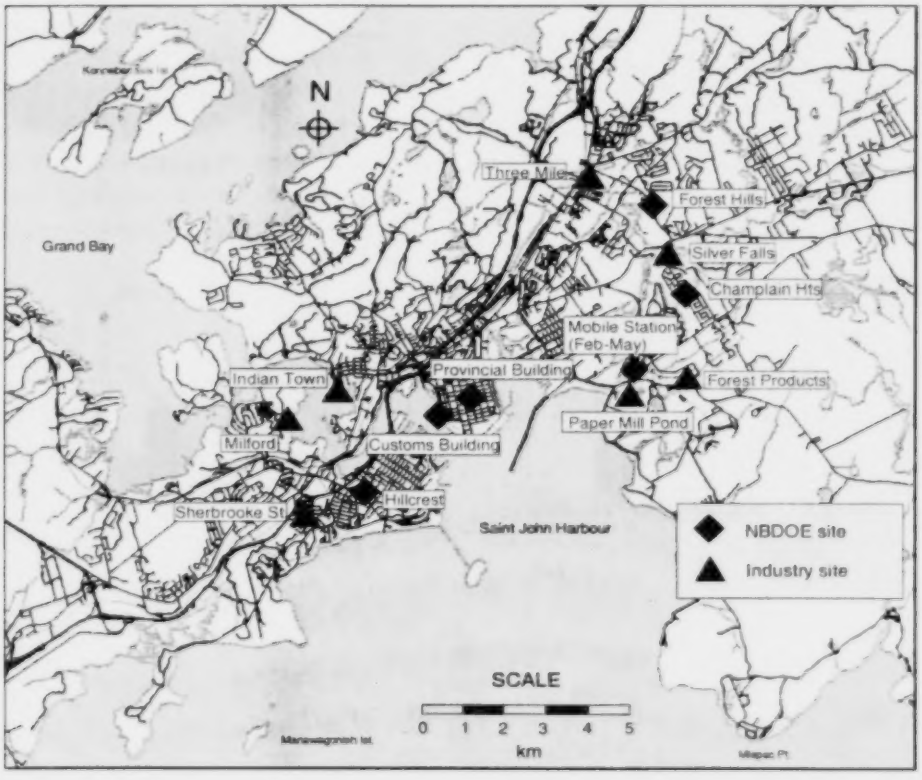


Figure 3. Air quality monitoring sites in Saint John, New Brunswick, 2003.

Most of these sites are electronically linked to a central computer at the DELG regional office in Saint John. This system communicates with the monitors a minimum of once each hour and obtains the latest readings. These are then added to the existing data archive and are used to prepare IQUA public information messages, as well as to determine the nature of any abatement actions required by industries if concentrations rise above pre-determined trigger points. Such episode control systems are specified in various Approvals to Operate issued to major emission sources by the Department.

On the City's west side, three monitoring sites for total reduced sulphur are operated by Irving Pulp and Paper Ltd. DELG also operates a site at the Hillcrest Baptist Church off Lancaster Avenue, at which sulphur dioxide, total reduced sulphur, ozone and particulate matter are monitored. In east Saint John, three sites for sulphur dioxide and one for $PM_{2.5}$ particulate matter are operated by Irving Oil Ltd., as required by the company's operating approval, and results are sent electronically to the Department's data system. In 2003, the Three Mile Irving site was closed down in February. A new site, Paper Mill Pond, was established to the south of the refinery in March, at which sulphur dioxide is measured.

DELG also maintains sites at Forest Hills and Champlain Heights in the eastern suburbs, and at the Customs Building and Provincial Building in the uptown area. The Customs site has monitors for ozone, sulphur dioxide, nitrogen dioxide and carbon monoxide. At Forest Hills there are monitors for ozone, sulphur dioxide, nitrogen oxides, PM_{10}, $PM_{2.5}$ and volatile organic compounds (VOCs). At the Champlain Heights School, sulphur dioxide, total reduced sulphur, nitrogen dioxide, VOCs and $PM_{2.5}$ are measured.

A.1 Carbon Monoxide

This pollutant is monitored at the Customs Building site to provide data representative of the city centre. Peak hourly values in every month seldom exceeded 2.5 ppm, and were thus well below the applicable objective of 30 ppm in 2003. There were also no exceedances of the 8-h objective of 13 ppm.

A.2 Nitrogen Dioxide

There were no exceedances of the 1-hour objective of 210 ppb at either the Forest Hills or Customs Building monitoring sites in 2002. Neither were the 24-hour objective (105 ppb) or the annual objective (52 ppb) exceeded. However, monthly mean and peak readings were in general significantly higher than in 2003. The reasons for this are speculative, but could include construction activity in the immediate area (known to have been occurring in 2003) and an increased frequency of cruise ship visits to the nearby port.

A.3 Sulphur Dioxide

Exceedances for sulphur dioxide are summarised in tables on the following page. During 2003, the number of exceedances increased in comparison to 2002. Most of the exceedances occurred at the Silver Falls and Paper Mill Pond sites, whereas the sites in west Saint John (Customs and Hillcrest) recorded no exceedances.

A.3.1 Sulphur Dioxide Episode Control

An episode control program is in place to prevent ambient sulphur dioxide reaching undesirably high levels in Saint John. Control actions are initiated by major industries in the city in response to measurements made at the fixed monitoring sites.

Exceedances of the 1-hour sulphur dioxide standard in 2003 Saint John (number of hours)													
Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Forest Hills							1						1
Champlain Hts			1										1
Hillcrest													0
Customs													0
Three Mile													0
Forest Products							2						2
Silver Falls			1	1			4	1	2	1			10
Paper Mill Pond	-	-	8	7	7	6		4			13	2	47
Mobile Unit													0
Total			10	8	7	6	7	5	2	1	13	2	61

The 1-hour objective is 170 ppb.

Exceedances of the 24-hour sulphur dioxide standard in 2003 Saint John (number of hours)													
Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Forest Hills							23						23
Champlain Hts		13	23							11			47
Hillcrest													0
Customs													0
Three Mile													0
Forest Products								3					3
Silver Falls			5			36	64	12					117
Paper Mill Pond	-	-	24	63	118	51		26		39	18	34	373
Mobile Unit													0
Total	-	13	52	63	118	87	87	41		50	18	34	563

The 24-hour objective is 56 ppb.

As noted earlier, these control actions are made mandatory by being incorporated into the relevant Approvals to Operate issued by DELG. The episode control plans themselves are subject to continual review. DELG meets regularly with staff of the major industries in the city to review compliance in respect of sulphur dioxide.

All exceedance events are examined in detail and any shortfalls in the nature and extent of response action are addressed. DELG staff sometimes request emission control actions separate from or in addition to those specified in the response plans. Such action may be warranted due to unusual conditions, such as poor dispersion, or during periods when smog advisories are in effect.

Some of the ways in which industries respond to rising levels of sulphur dioxide include switching to lower or near-zero sulphur fuels, and reducing production rates or electricity generating rate. Response action is begun when monitored concentrations reach 80 parts per billion, approximately half the 1-hour objective of 170 parts per billion.

A.4 Ground Level Ozone

Ozone was monitored at three sites in the city during 2003: Forest Hills, the Customs Building and in west Saint John at Hillcrest Church. During 2003 there were no exceedances of the 1-hour National Ambient Air Quality Objective for ozone of 82 ppb in the Saint John Network. Statistics were also calculated in reference to the Canada-Wide Standard (CWS) for ozone, which is based on an 8-hour averaging period and is set at 65 parts per billion. There was a total of 5 hours in excess of this value, one hour at Forest Hills in June and four hours at Hillcrest in August. New Brunswick (and other provincial governments) have committed to be in compliance with the CWS for ozone by 2010. In the interim, CWS compliance statistics are calculated and presented for general assessment purposes.

Further details on ground level ozone follow in section 11, where complete results for all ozone monitoring sites are summarised.

A.5 Particulate matter

A.5.1 PM_{10} High Volume Sampler

DELG operated high volume samplers (modified to provide data on PM_{10}) at two sites in Saint John in 2003: Provincial Building, and Hillcrest. As noted earlier, there is no Canadian National Objective presently in place for PM_{10}, and no provincial objective in New Brunswick. For evaluation purposes, reference is made to the standards in place in Greater Vancouver, the United States, and the State of California (page 6).

Monitoring results at the two Saint John sites were low during 2003, with no exceedances of the California/GVRD 24-hour standard of 50 micrograms per cubic metre at any location.

A.5.2. PM_{10} (TEOM)

PM_{10} was measured during 2003 at Forest Hills using a continuously recording TEOM instrument. Continuous recording provides complete coverage for all hours in the year, as opposed to the 1 in 6 day schedule used nationally for high volume samplers.

The 2003 results comprised over 7 000 hours, or about 80% of the year. Hourly peak values were typically around 60—90 micrograms per cubic metre during most months. Some jurisdictions have a standard of 50 micrograms per cubic metre for PM_{10}, averaged over 24 hours. This value was not exceeded during 2003.

A.5.3 $PM_{2.5}$ (TEOM)

Forest Hills

Valid data were logged for over 95% of the total hours of the year. There were some hourly peaks of over 50 micrograms per cubic metre., The Canada-Wide Standard for $PM_{2.5}$ is 30 micrograms per cubic metre as a 24-hour average, itself averaged over 3 years (see box). In 2003, there were four days having a 24-hour average exceeding the 24-hour average of 30 micrograms per cubic metre, June 27 and 28, and July 27 and 28. The 98th percentile reading for the year was 18.5 micrograms per cubic metre.

Champlain Heights

Continuous $PM_{2.5}$ measurements are made at this site using an instrument known as a beta attenuation monitor, or BAM. This technology differs from the TEOM, and results may not be directly comparable. Detailed intercomparison of continuous particulate measurement methods is ongoing in Canada, the US, and around the world.

At this site, hourly values of $PM_{2.5}$ were mostly under 40 micrograms per cubic metre. There were 11 days during the year having a 24-hour average exceeding the 24-h CWS guidelines of 30 micrograms per cubic metre, occurring in July, August and October. The 98th percentile reading for the year was 27.7 micrograms per cubic metre.

Canada-Wide Standard for $PM_{2.5}$: Determining Compliance

Determining compliance with the Canada Wide Standard for $PM_{2.5}$ requires a number of calculations. From all the daily 24-hour averages for the year, the value is computed which is greater than 98% of all the readings. In other words, only 2% of the readings exceeded this value during the year. This is the 98th percentile value. A site is considered in compliance if the average of the 98th percentile values over three consecutive years is below 30 micrograms per cubic metre.

A.6 Total Reduced Sulphur

Total reduced sulphur (TRS) is monitored at the Hillcrest site and at Champlain Heights (NBDELG) as well as three sites operated by Irving Pulp and Paper (Milford, Indian Town and Sherbrooke St.). The NBELG Mobile Monitoring Unit was also used in Saint John from February to May 2003, at the Irving Oil Refinery construction parking area.

There was one 1-h exceedance at Sherbrooke. There were no 24-h exceedances at any site in the network. The Mobile Unit logged no exceedances at the refinery location. Note: for evaluation of TRS data, and in the absence of a specific objective for TRS, reference is made to the provincial objectives for hydrogen sulphide.

A.7 Volatile Organic Compounds (VOCs)

VOCs have been measured at Forest Hills in east Saint John since 1992. Measurements have also been made for the same period of time at Point Lepreau, approximately 40 km southwest of the city. The Lepreau site is predominantly upwind of Saint John and serves as a control or reference site, representative of rural southern New Brunswick. In July 2000, VOC sampling was begun at Champlain Heights in east Saint John. The monitoring program for VOCs is a collaborative one between DELG and Environment Canada. DELG staff maintain the monitoring sites and set up the equipment to take samples (normally every 6 days). Environment Canada performs the analyses on the collected air samples.

Sites in Saint John collect one 24-hour sample every 6 days and the rural site at Point Lepreau collects a 4 hour sample beginning at noon, every 3 days. All samples are analysed for over 150 compounds, which include VOCs which are involved in the formation of ozone, as well as VOCs which may be of interest for other reasons. For example, they may be indicators of various kinds of industrial activity, or they may be potentially of concern in their own right (for example, substances which are known to be carcinogenic, such as benzene). Some other VOCs which are measured are found at similar concentrations regionally or even globally (such as several CFC compounds). These substances are of key interest in atmospheric research.

There are no ambient air quality standards for VOCs in Canada. Results can be compared against guidelines published by other agencies, and examined over time to look for trends, as well as differences between sites.

The table on the following page lists results for 2003 for selected VOCs, compared with guidelines recommended by various agencies. This subset of VOCs contains compounds which have traditionally been classified as "air toxics", and which are considered potentially harmful to human health. The first line of the results table also shows the average concentration taking into account all VOCs measured at each site (total VOC).

Results from Champlain Heights were once more higher than those measured at Forest Hills. Both sites had higher concentrations of most VOCs than the Point Lepreau site.

For the selected VOCs for which guidelines could be referenced, concentrations at both monitoring sites were found to be below these targets at both sites, in most cases by a substantial margin. The annual guideline for benzene recently published in the United Kingdom (5 ppb) has a compliance target date of 2003, with the long-term target being a guideline of 1 ppb (EPAQS, 1994, HMSO, 2000). Benzene is emitted from motor vehicles and is a component of gasoline. In Saint John, the petroleum refinery and other industries would also contribute to ambient concentrations, which were below the Swedish guideline of 1.5 ppb, which has a compliance date of 2010 (Swedish EPA, 2003). Additional analysis of VOC data is included in the section on long-term trends (section 14).

MTBE

MTBE, or methyl tertiary butyl ether, is a gasoline additive called an "oxygenate", designed to improve combustion of the fuel. Improved combustion can result in lower emissions of carbon monoxide and VOCs (essentially unburned fuel) which contribute to the formation of ground-level ozone. However, MTBE has proven to be a controversial and problematic substance. Although it appears to offer benefits as a motor fuel additive in terms of exhaust emissions, these beneficial properties are offset by the ability of MTBE to dissolve freely in water. MTBE has a pungent, turpentine-like odour and taste, even at very low concentrations (15-20 ppb). It can rapidly contaminate underground water supplies if there are gasoline leaks or spills, rendering the water unusable for drinking. Because of the contamination problems caused by MTBE, its use as an additive in gasoline is being phased out in many areas in favour of other oxygen-containing alcohols such as ethanol (USEPA, 1999).

Human health concerns regarding MTBE have tended to focus on the potential for the compound to be carcinogenic, or cancer-

2003 VOC Monitoring Results							
VOC	Max 24-h averages (ppb)		24-h guidelines (ppb) (WHO)	Annual averages (ppb)			Annual Guidelines (ppb)
	Forest Hills	Champlain Hts		Forest Hills	Champlain Hts	#Point Lepreau	
Total VOC	241.7	452.5		50.7	106.8	6.79	
1,3 butadiene	0.18	0.41		0.05	0.05	0.01	1 (UK)
Benzene	1.13	3.00		0.38	0.73	0.11	5(UK) 1.5 (Sweden)
Toluene	4.97	11.70	63*	0.98	0.73	0.11	10-100 (Sweden)
Ethylbenzene	0.37	1.20	4464*	0.10	0.30	0.01	
Xylenes	1.01	3.55	1013	0.27	0.86	0.02	
Styrene	0.11	0.02	56*	0.01	0.01	0.01	
Chloromethane	0.91	0.85		0.70	0.60	0.57	
Vinyl chloride	0.00	0.00		0.00	0.00	0.00	
1,1 dichloroethylene	0.01	0.00		0.00	0.00	-	
Dichloromethane	0.73	0.15	792	0.07	0.07	0.29	100-250 (Sweden)
1,2 dichloroethane	0.02	0.04	159	0.01	0.02	0.01	100-150 (Sweden)
Carbon tetrachloride	0.12	0.11		0.10	0.10	0.09	
1,2 dichloropropane	0.00	0.00		0.00	0..00	-	
Trichloroethylene	0.02	0.02		0.01	0.01	0.01	100-200 (Sweden)
1,1,2 trichloroethane	0.00	0.01		0.00	0.00	0.00	
Ethylene dibromide	0.00	0.00		0.00	0.00	-	
Tetrachloroethylene	0.08	0.03	34	0.02	0.01	0.01	
1,1,2,2 tetrachloroethane	0.00	0.00		0.00	0.00	-	
Formaldehyde	3.58	4.55		1.15	2.17	-	
Acetaldehyde	2.91	3.13		0.81	1.22	-	
MTBE	11.30	39.50		2.69	9.43	-	

Notes: The guidelines marked with an asterisk (*) are for a weekly period.
Sources: WHO (World Health Organisation): 1987, 1994,1996 & 1997; Swedish standards: OECD, 1995; Swedish EPA, 2003. UK standards: HMSO, 2000. # Data at Pt Lepreau are collected for 4 hours each sample day, starting at noon AST. The other sites are based on 24-h samples every 6th day.

causing. Reviews have been completed in recent years by at least eight different agencies (e.g. as summarised in European Fuel Oxygenates Association, 1999). Among these, the International Agency for Research on Cancer has described MTBE as "not classifiable" in terms of carcinogenicity. Although it is acknowledged that MTBE can induce tumours in rodents in laboratory tests, there are no data available for effects in humans. It is viewed by other bodies as a "potential" human carcinogen (Froines et al., 1999).

The ongoing use and emissions of MTBE are limited to Atlantic Canada: only Irving Oil and North Atlantic Refining (Newfoundland) indicated that they intend to continue producing gasoline containing MTBE after 2001, according to an Environment Canada survey (Environment Canada, 2001). Both these refineries supply the US market for reformulated gasoline, which must contain an oxygenate. Although North Atlantic Refining reported that it plans to continue marketing MTBE-containing gasoline in Canada, Irving Oil indicated that it will not. As such, releases of MTBE in the Saint John area

should be almost exclusively from the refinery complex, as opposed to releases from vehicles or filling stations.

MTBE has been monitored as part of the VOC sampling program at Forest Hills and Champlain Heights. There are no ambient air guidelines for MTBE. The human health risk assessment prepared by Cantox Environmental at the time of the expansion of the refinery (Cantox, 1999) did take note of MTBE as a "substance of concern".

Monitoring results for MTBE in ambient air are shown in figures 4 and 5. MTBE concentrations have tended to be higher at Champlain Heights than at Forest Hills. At both sites, values have been quite variable and there is no clear overall trend. MTBE values will be tracked in future and can be expected to fall progressively as the substance is phased out of use as a fuel additive.

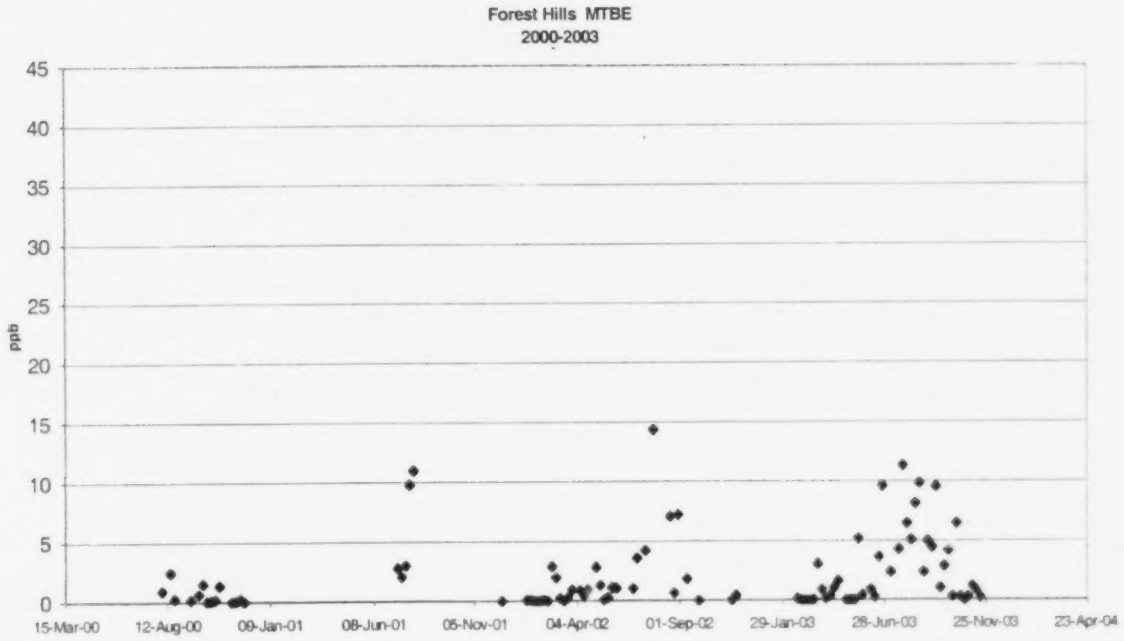


Figure 4. MTBE at Forest Hills, Saint John, 2000-2003.

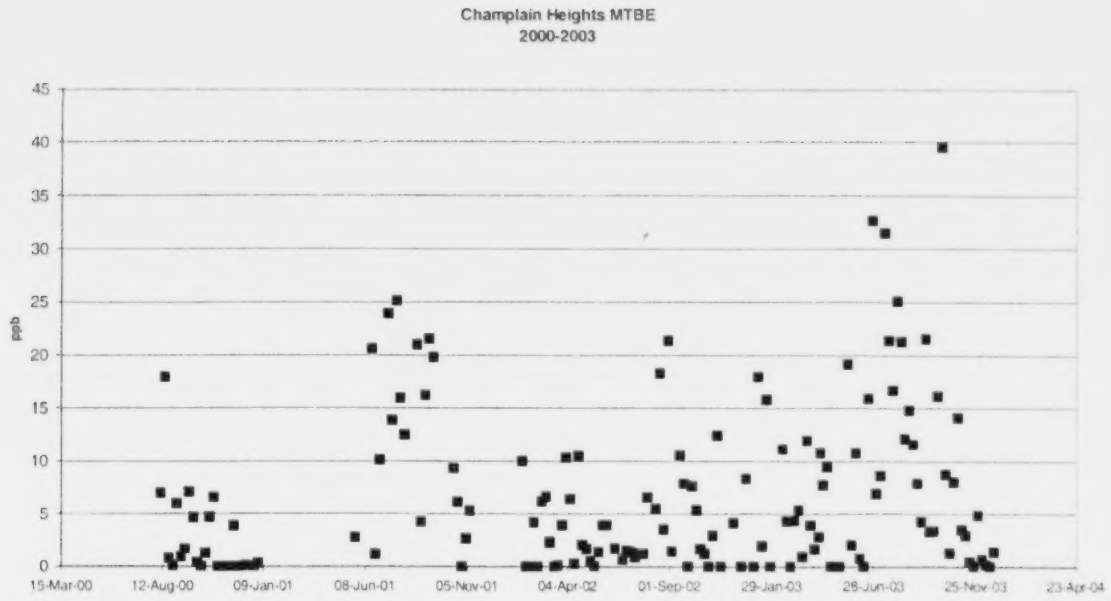


Figure 5. MTBE at Champlain Heights, Saint John, 2000-2003.

A.8 Index of the Quality of the Air (IQUA)

The IQUA system has been used in Saint John for over 20 years to help make air quality monitoring results easier to understand. Results for each pollutant measurement are expressed on a scale from 1-100, and classed as "good" (index 0 to 25), "fair" (26 to 50), "poor" (51 to 100) or "very poor" (over 100). Each of the categories is based on the National Air Quality Objectives listed in Appendix II. For example, "good" air quality indicates that pollutants are in the "desirable" range as defined by the air quality objectives. Values in the "fair" range are above the desirable, but below the acceptable objective. IQUA information is distributed daily via the DELG web site:

http://www1.gnb.ca/0355/0003/0000.asp

The IQUA System

National Air Quality Objective		IQUA Level
Exceeds Maximum Tolerable	VERY POOR	100 or more
Exceeds Maximum Acceptable	POOR	51-100
Exceeds Maximum Desirable	FAIR	26-50
Lower than Maximum Desirable	GOOD	0-25

This web page is updated three times per day. IQUA information is also accessible by phone via recorded message (dial 636 4991 in the Saint John area). The recorded message is updated hourly.

For each hour, the IQUA index is computed for each pollutant measured at the site. The value reported is the highest of each of the individual values. For example, if two pollutants are in the "good" range and one is in the "poor" range, then the index for the hour would be reported as "poor". In addition, the pollutant responsible for determining the overall index value is usually identified.

Summary statistics are given in the following table for the three designated IQUA sites in Saint John: Customs Building (uptown), Forest Hills (east) and Hillcrest (west). The table shows the number of hours logged in each IQUA category. It is apparent that the vast majority of the time, air quality was in the "good" category during 2003 (more than 97% of the time). The percentage of hours in the "fair" range was less than 3% at all sites, and there were no hours recorded in the poor or very poor categories.

IQUA Summary 2003: Saint John Sites (%)				
	Good (0-25)	Fair (26-50)	Poor (51-100)	Very Poor (over 100)
Forest Hills	98.6	1.4	0	0
Customs	98.7	1.3	0	0
Hillcrest	97.8	2.2	0	0

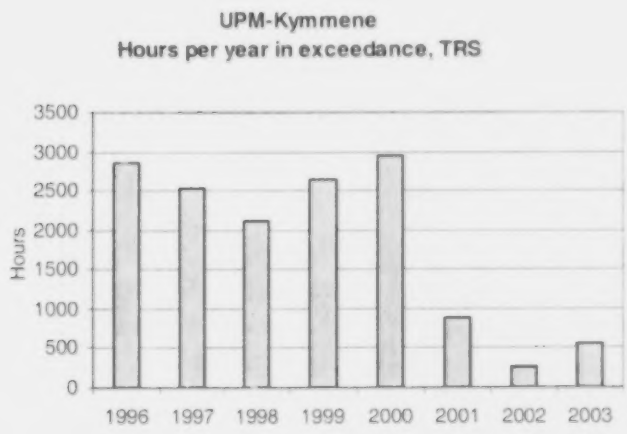


Figure 6. TRS exceedances at UPM-Kymmene, 1996-2003.

B. MIRAMICHI

There are three monitoring sub-networks in the Miramichi region, one centred on the UPM pulp mill emission sources, another on NB Power's Millbank gas turbine generating site, and a third operated by the Weyerhaeuser Company. Pollutants of concern in these networks include hydrogen sulphide and particulates (UPM) plus nitrogen dioxide and sulphur dioxide (Millbank).

Figure 7 shows the locations of the sites in the region.

B.1 UPM NETWORK

B.1.1 Total Reduced Sulphur

Compliance in 2003 decreased somewhat compared with 2002, but remained relatively good in comparison to the period 1996-2000 (see Figure 6 on page 27). There was a small number of exceedances at the Groundwood site. Exceedances are summarised in tables on the following page.

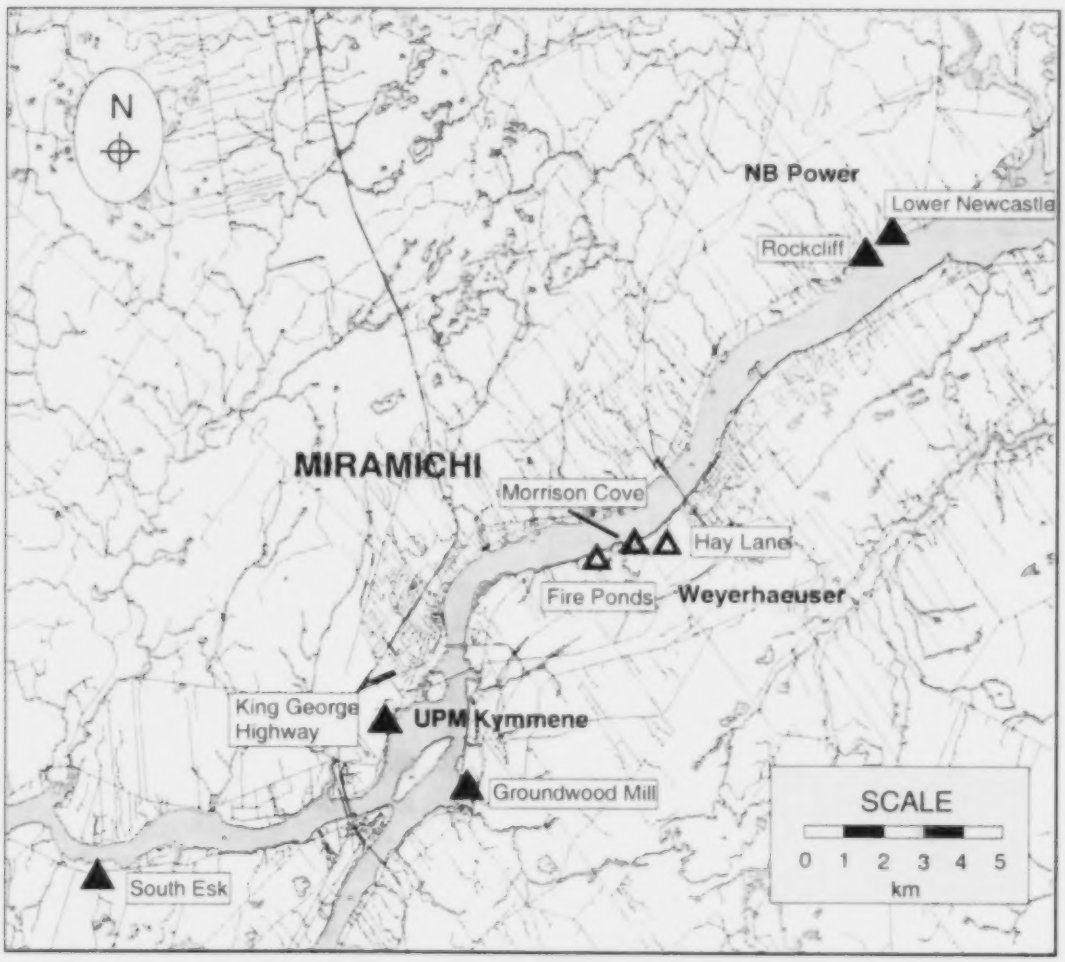


Figure 7. Air quality monitoring sites in the Miramichi Region.

Exceedances of standards for Hydrogen Sulphide in 2003, Measured as TRS UPM sites (number of hours)													
1-hour standard (11 ppb)													
Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Groundwood						1		1					2
KG Highway	2	0	0	2	2	0	3	32	3	5	5	2	56
Total	2	0	0	2	2	1	3	33	3	5	5	2	58
24-hour standard (3.5 ppb)													
Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Groundwood											5		5
KG Highway	6	0	25	7	16	48	35	134	83	46	13	78	491
Total	6	0	25	7	16	48	35	134	83	46	13	78	496

Note: for evaluation of TRS data, and in the absence of a specific objective for TRS. reference is made to the provincial objectives for hydrogen sulphide.

In August 2003, a 2-week maintenance shutdown of No.4 woodwaste boiler, which burns odorous non-condensible gases, resulted in higher than expected hours of exceedances for the year due to the venting of these gases. Sixty percent of the one-hour exceedances and 30% of the 24-hour exceedances for the year occurred during this 2-week period.

An Amendment to UPM's Air Quality Operating Approval is being prepared which will require UPM to develop a "Phase II TRS Reduction Plan" and which will also include a section dealing with No.4 woodwaste boiler outages.

B.1.2 Total Suspended Particulate

There were no exceedances of the TSP standard at any of the three stations in the network during 2003. Detailed results are shown in Appendix II.

B.2 MILLBANK NETWORK

The two sites at Millbank (Rockcliff and Lower Newcastle, see Figure 6) are positioned to assess the impact of NB Power's gas turbine generating station. The pollutants monitored include sulphur dioxide, nitrogen dioxide and TSP (Rockcliff only).

B.2.1 Nitrogen dioxide

There were no exceedances of the 1-hour or 24-hour objective at either monitoring site in 2003, and monthly means were all very low. Monthly results for 2003 are shown in Appendix II.

B.2.2 Sulphur dioxide

There were no exceedances of the 1-hour or 24-hour objective at either site in the network. The monthly means were also very low. Monthly results are shown in Appendix II.

B.2.3 Total Suspended Particulate

None of the measurements made at the Rockcliff site exceeded the 24-hour objective of 120 micrograms per cubic metre in 2003,

and almost all were well below this value. Detailed results are given in Appendix II.

B.3 WEYERHAEUSER

B.3.1 Total Suspended Particulate

Weyerhauser operates a manufacturing plant for oriented strand board, located on the south shore of the Miramichi River. Two sites are maintained by this company for TSP, one at Morrison Cove and one in the Mirview Subdivision. The sampling schedule in 2003 was every sixth day.

During 2003, there were two exceedances of the 24-h standard of 120 micrograms per cubic metre, at the Fire Ponds site, in June, and one exceedance at Morrison Cove (also in June). The annual objective of 70 micrograms per cubic metre was not exceeded at either site. Data are summarised in detail in Appendix II.

C. GRAND LAKE - NB POWER

Figure 8 shows the locations of the four monitoring sites in this network. These are sited to monitor the effects of the Grand Lake coal-fired electrical generating station and associated activities. The four monitoring sites are operated by NB Power and each measures sulphur dioxide and TSP.

C.1 Sulphur dioxide

There was a total of 6 exceedances of the 1-h standard of 340 parts per billion, 3 at Newcastle Centre, 2 at Flowers Cove, and 1 at Bailey Point. The 24-h objective of 113 ppb was not exceeded at any site.

C.2 Total Suspended Particulate

In 2003, there were no exceedances of the 24-hour objective of 120 micrograms per cubic metre in this network. Complete results are given in Appendix II.

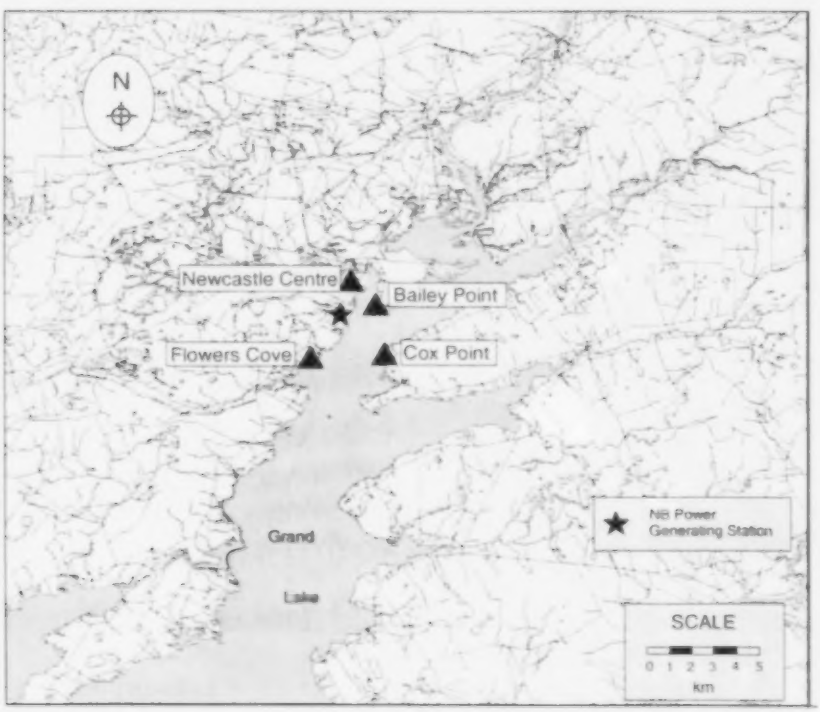


Figure 8. Air quality monitoring sites in the Grand Lake Network.

D. EDMUNDSTON – FRASER INC.

Figure 9 shows the locations of the monitoring sites, located primarily to monitor the impacts of the Fraser Inc. pulp mill.

D.1 Sulphur Dioxide

At the Cormier and Saint Mary locations, there were no exceedances of the 1 hour or the 24-hour standard during 2003.

D.2 $PM_{2.5}$ Particulate Matter

Continuous fine particulate measurements (TEOM) began at the Cormier site in June 2000. In 2003, hourly averages rarely exceeded 80 micrograms per cubic metre, although there were some hours with readings greater than this. There were 12 days having a 24-hour average exceeding the Canada-Wide Standard of 30 micrograms per cubic metre, in February, March and June.

The annual 98th percentile value was 30.2 micrograms per cubic metre. Detailed results are shown in Appendix II.

D.3 Total Suspended Particulate

No exceedances were recorded at the St Mary site during 2003. See also Appendix II.

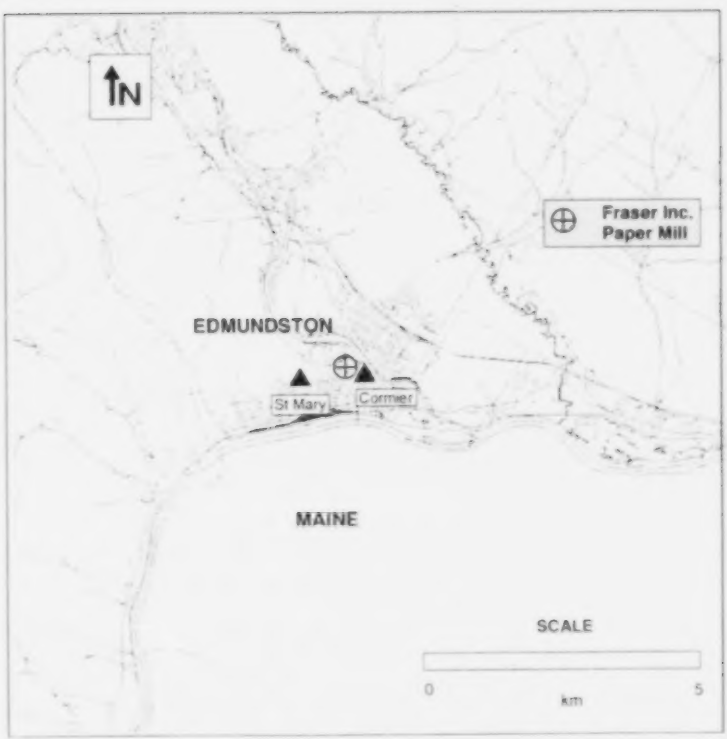


Figure 9. Air quality monitoring sites in Edmundston.

E. BELLEDUNE

There are a number of monitoring sites in the Belledune region. Four of these are located for the assessment of emissions from the Brunswick Mining and Smelting complex. A further five monitors are operated for the assessment of NB Power's coal-fired electrical generating station.

Figure 10 shows the locations of all the monitoring sites in the region.

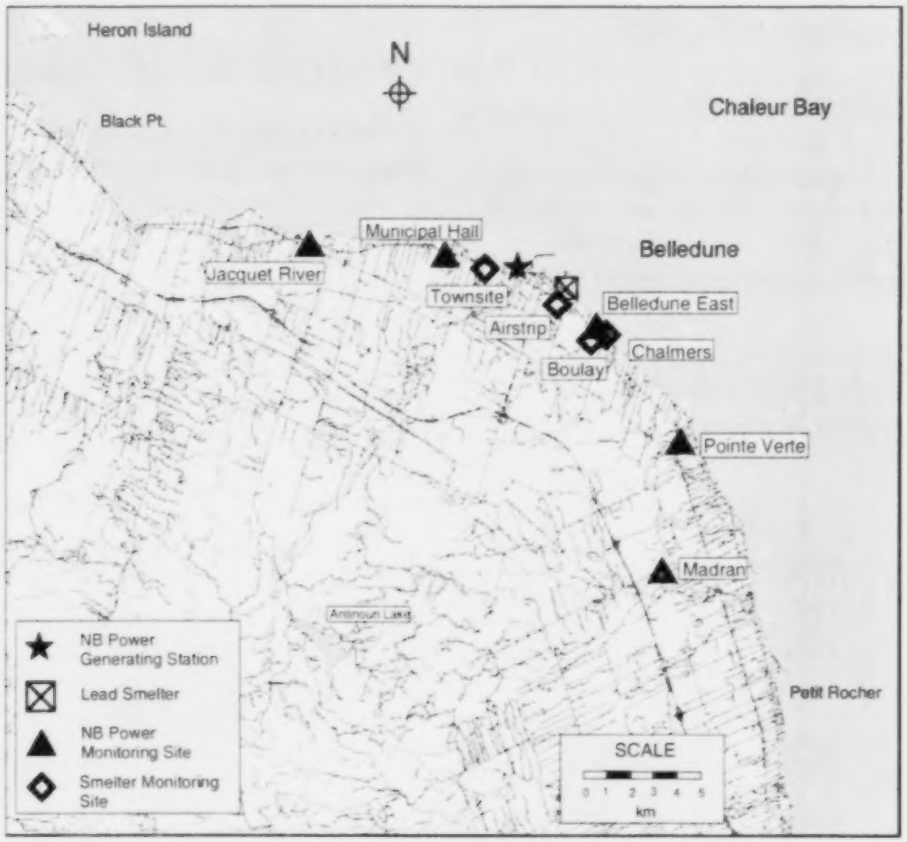


Figure 10. Air quality monitoring sites in the Belledune Network.

E.1 BRUNSWICK MINING AND SMELTING

All sites in the Brunswick Mining and Smelting network monitor sulphur dioxide, and three also measure TSP.

E.1.1 Sulphur dioxide

In 2003 there were some exceedances of the 1-hour objective, as summarised below. The 1 hour objective is 340 ppb. There were no exceedances of the 24-hour objective (113 ppb) at any station. There were technical problems in this network from June toDecember, that resulted in data being invalidated for this period.

Exceedances of the 1-hour sulphur dioxide standard in 2003
Brunswick Mining and Smelting, Belledune (number of hours)

Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Airstrip						1	M	M	M	M	M	M	(1)
Chalmers		1			1	1	M	M	M	M	M		(3)
Townsite						M	M	M	M	M	M		0
Boulay						M	M	M	M	M	M		0
Total		1			1	2	M	M	M	M	M	M	(4)

The 1 hour objective is 340 ppb.

E.1.2 Total Suspended Particulate

Technical problems were experienced during 2003 with this network, resulting in all data being invalidated.

E. 2 NB POWER

There are five sites in this network, all of which monitor for sulphur dioxide. Two sites also monitor nitrogen dioxide.

E.2.1 Sulphur dioxide

During 2003 there were four exceedances of the 1-hour objective, as summarised below.

In 2003 there were no exceedances of the 24-hour objective of 113 ppb or annual objective of 23 ppb at any site.

Exceedances of the 1-hour sulphur dioxide standard in 2003
NB Power Network, Belledune (number of hours)

Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Madran													0
Pointe Verte			0										0
Belledune E		1		2									3
Jacquet River													0
Municipal Hall						1							1
Total		1		2		1							4

The 1 hour objective is 340 ppb.

E.2.2 Nitrogen dioxide

This contaminant is measured at Belledune East and Municipal Hall. There were no exceedances of the applicable 1 or 24-hour objectives in 2003 at either location.

F. DALHOUSIE – NB Power

Figure 11 shows the locations of the sites in the region. The sites in this region are operated to monitor the effects of the NB Power Dalhousie electrical generating station. Six sites measure sulphur dioxide. One of the six also monitors for TSP, and there is one additional TSP site (7 sites in all). Because of potential pollution transport across the Bay of Chaleur, one of the stations is located in the province of Québec.

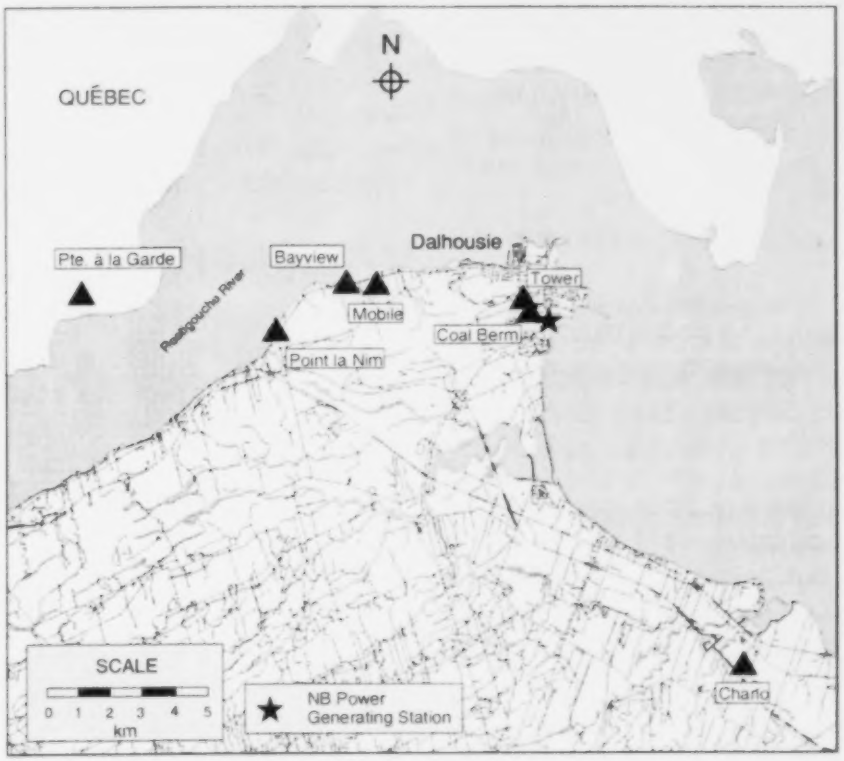


Figure 11. Air quality monitoring sites in the Dalhousie Network.

F.1 Sulphur dioxide

Compliance with the applicable 1-hour, 24-hour and annual objectives was 100% at all sites in 2003. Detailed summaries are given in Appendix II.

F.2 Total Suspended Particulate

TSP was measured at the Coal Berm and Dalhousie Tower sites. Results are shown in Appendix II. None of the individual readings obtained was above the 24-hour objective of 120 micrograms per cubic metre in 2003, and the annual geometric means were also below 10 micrograms per cubic metre (the standard is 70 micrograms per cubic metre).

G. ATHOLVILLE - AV CELL INC.

G.1 Sulphur dioxide

AV Cell Inc. operates a pulp mill in Atholville, and maintains two associated ambient air monitoring sites, Boom Road (to the west of the mill) and Beauvista (east). Sulphur dioxide is measured at both sites.

Compliance during 2003 was 100% with no exceedances of the 1-hour objective (340ppb), 24-h objective (113 ppb) or the annual objective (23 ppb) at either site.

H. BATHURST

H.1 $PM_{2.5}$

The Bathurst monitoring station did not operate during 2003 due to vandalism.

I. FREDERICTON

The Fredericton site is on Aberdeen Street, in an area representative of the "downtown" residential and business district. The site is also considered representative of a wider area for pollutants, such as ozone, which are regional in nature.

I.1 Carbon monoxide

No exceedances of the 1-hour or 8-hour objectives (respectively 30 ppm and 13 ppm) were recorded. Peak values were higher in the fall and winter months than during the summer, but even then, peak hourly readings were only about 10% of the standard.

I.2 Nitrogen dioxide

No exceedances of the 1 or 24-hour objectives (210 ppb and 105 ppb) were recorded. As for carbon monoxide, higher readings were seen in the cooler months, but levels remained low. The highest hourly readings were about 25% of the standard.

I.3 Ground level ozone

There were no exceedances during 2003 of the national 1-hour objective for ozone. There were also no hours in exceedance of the Canada-Wide Standard of 65 ppb (8-h average). The annual CWS statistic was 54.3 ppb. There is additional discussion of data from the ozone network in section 11.

I.4 $PM_{2.5}$ Particulate matter

Fine particulate matter ($PM_{2.5}$) was measured at the Aberdeen Street site using a TEOM instrument, which provides a continuous record of particulate concentrations. Data obtained during 2003 indicated generally moderate to low particulate concentrations. There were two days with a 24-hour average exceeding the Canada-Wide Standard of 30 micrograms per cubic metre, June 28 and August 21. The June episode occurred during a hot spell of weather characterised by regional smog. The August 21 event was also seen across the province and was due to forest fire smoke originating in Manitoba. The 98th percentile value for 2003 was 18.7 micrograms per cubic metre.

I.5. Index of the Quality of the Air

Results for 2003 showed air quality in the "good" category for 98.8% of the time, with 1.2% in the "fair" range. Ozone was responsible for the small number of hours in the fair range. Results were made available hourly via recorded voice message at 451 6000.

J. NACKAWIC

Sulphur dioxide, total reduced sulphur (TRS) and total suspended particulate (TSP) are measured at the Caverhill Road site, as well as wind speed and direction.

Compliance was 100% for sulphur dioxide. For TRS, there was one exceedance of the hourly H_2S objective of 11 ppb during 2003, occurring in June. The 24-h objective of 3.5 ppb was not exceeded. The results for TSP showed low concentrations, with no exceedances recorded.

K. MONCTON

The Moncton air quality monitoring site is situated at the Highfield Street water pumping station. The site location was chosen to provide readings representative of the central city suburbs, which may be influenced by emissions from vehicles or institutional heating systems, as well as regional pollutants such as ozone.

K.1 Carbon monoxide

No exceedances of hourly or 8-hourly objectives for carbon monoxide occurred during 2003. Readings were similar to those recorded in downtown Saint John and Fredericton, remaining well below objectives.

K.2 Nitrogen dioxide

No exceedances of hourly or 24-hourly standards for nitrogen dioxide were recorded during 2003. However, there were missing data in March, April and from September to November. Maximum hourly values were less than 25% of the objective.

K.3 Ozone

There was one exceedance of the hourly objective for ozone (82 ppb) in August, and 9 exceedances of the Canada-Wide Standard (65 ppb over 8 hours), all occurring on one day in August. The annual CWS statistic was 59.1 ppb. More discussion of ozone data may be found in section 11.

K.4 $PM_{2.5}$ Particulate matter

The 2003 results revealed few hourly values over 40 micrograms per cubic metre. There was one day (August 21) with a 24-hour average exceeding the Canada-wide Standard of 30 . The 98th percentile value for the year was 17.2 micrograms per cubic metre, compared to the CWS criterion of 30.

K.5 Index of the Quality of the Air

Hourly IQUA reports are generated for the Moncton site and made available via recorded message at 851 6610. Summary statistics for 2003 indicated that good air quality was recorded for 98.6% of all hours in 2003, and fair for the remainder (1.4%). The fair readings were due to ozone.

L. ST. ANDREWS

The St. Andrews monitoring station is located on the grounds of the Huntsman Marine Science Centre and is operated with the support of staff from the Centre and DELG. This site has been used for a variety of special sampling projects and is especially suitable for investigating trans-boundary air pollution. Currently, projects operated at St. Andrews by the province include ozone and $PM_{2.5}$ monitoring. Additionally, mercury concentrations in air are monitored at this site, in collaboration with Environment Canada. This is the only location in the province where these mercury measurements are made, and one of only two locations in the Maritimes. Note: mercury measurements in precipitation ceased at this location in December 2003.

L.1 $PM_{2.5}$ (TEOM)

The St. Andrews TEOM unit collected valid data for over 95% of the year during 2003. In general, readings were very low at this site. Hourly values seldom exceeded 30 micrograms per cubic metre, with the majority below 15-20 micrograms per cubic metre. On August 22, during a regional smog episode, 24-h average levels approached the Canada-Wide Standard of 30 micrograms per cubic metre. The 98th percentile value for the year (based on 24-hour averages) was 13.1 micrograms per cubic metre.

L.2 Mercury monitoring

Mercury is of concern as an environmental contaminant because of its ability to accumulate in living organisms, potentially reaching concentrations which could pose a hazard to health in humans and wildlife (e.g. NESCAUM, 1998). Although mercury has been recognised as an environmental pollutant for decades, relatively little monitoring and assessment of the transport and behaviour of mercury in the atmosphere has taken place. Most attention has been paid to direct discharges, for example of industrial, water-borne effluents. In 1998, the New England Governors and Eastern Canadian Premiers identified mercury as a substance of concern in the east of Canada and the United States, and developed an Action Plan to improve our understanding of its impacts, and also proposed measures to reduce man-made emissions (NEGECP, 1998).

Mercury monitoring conducted at St. Andrews contributes to the scientific understanding of mercury in the environment. The results are used in research (for example, into atmospheric processes) as well as in wildlife and other studies.

The following table summarises results of the mercury monitoring program so far. These monitoring studies are operated cooperatively between Environment Canada, the Huntsman Marine Science Centre, and DELG.

There are no environmental guidelines or objectives for mercury in air or precipitation at present. The data may be used to look for patterns or trends over time, and to compare regionally with other locations. They are also used as input to ecological models which attempt to track how mercury moves though different components of the environment. The results show several things. In ambient air, the concentration of mercury in vapour form typically varies between approximately 1.5 and 2 nanograms per cubic metre as an annual average. These values are similar to those measured in Nova Scotia and rural southern Quebec, and lower than readings obtained at sites in parts of New England or southern Ontario, where they typically range from 2 to 3 nanograms per cubic metre (NESCAUM, 1998).

Over the course of a year, readings at St. Andrews tend to be highest in late winter and lowest in late summer. The reasons for this have not yet been fully explored, but the changing use of fossil fuels through the year is thought to be a major influence (NESCAUM, 1998). The 2003 results showed slightly higher air concentrations of mercury than previous years. However, data were only acquired from May to December.

Considering mercury measurements in precipitation, the trends seen at St. Andrews and at Kejimkujik, in southwestern Nova Scotia, are similar. Mercury concentrations have generally fallen at both sites since 1996. A detailed examination of results shows that the two sites occasionally exhibit significant differences in mercury concentrations for the same precipitation episodes.

Mercury Monitoring Results 1995-2003			
Ambient Air			
St Andrews		Other sites	
Year	Annual Average (ng/cubic metre)	Site	Annual averages (ng/cubic metre)
1995	1.9	Mt Mansfield, VT	2.0 (94-96)*
1996	1.5	Kejimkujik, NS	1.5 (1996)*
1997	1.4	Westfield, NY	2.6 (94-96)*
1998	1.4	Moss Lake, NY	2.4 (94-96)*
1999	1.6		
2000	1.4		
2001	1.4		
2002	(1.2)▼		
2003	1.5*		
Precipitation (rain and snow)*			
Year	Mean mercury concentration (ng/L)	Kejimkujik, N.S.	Mean mercury concentration (ng/L)
1996	7.5	1996	7.4
1997	6.7	1997	5.9
1998	5.8	1998	5.2
1999	6.5	1999	5.0
2000	6.5	2000	4.7
2001	6.3	2001	5.4
2002	4.6	2002	5.2
2003	5.2	2003	4.6
Notes: ng = nanograms. 1 nanogram is one thousand-millionth of a gram. Ambient air mercury data supplied by Environment Canada. ▼ Note: in 2002, sampler operated only January-July. * In 2003, sampler operated May-December		References: * NESCAUM (1998) ** NADP (2000)	

In 2003, the annual precipitation-weighted mean mercury concentration in precipitation was higher at St. Andrews than Kejimkujik, returning to a pattern seen since 1996, with the exception of 2002.

11. RURAL OZONE NETWORK

Figure 12 shows the locations of the sites which monitor ground level ozone in New Brunswick. This network is operated to assess the impact of long-range transported ozone. It focuses on the southern portion of the province, which is the region most affected by long range transport, as shown by special short-term monitoring studies and trajectory analyses (e.g. Fuentes and Dann, 1994; Tordon et al., 1994; Multistakeholder NOx/VOC Science Program, 1997a, 1997b). Two sites in the northern part of the province were added to the network in 2000, St. Leonard in the northwest, and Lower Newcastle in the northeast. Ground-level ozone readings

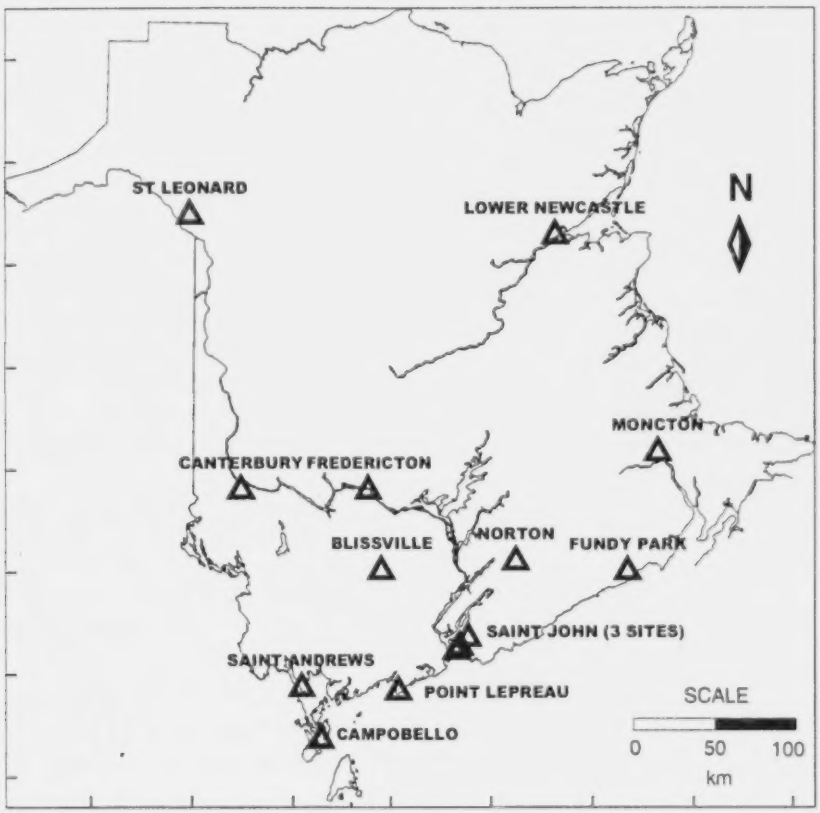


Figure 12. Locations of ozone monitoring sites in New Brunswick (2003).

in 2003 were generally similar to those in 2002. There were a number of exceedances of the 1-h objective of 82 ppb and more than 200 hours exceeding the 8-hour Canada-Wide Standard of 65 ppb, during episodes in May, June, July and August. The number of hours of exceedance is quite variable from year to year, being heavily influenced by the weather. Results are summarised in the following tables. The Canada-wide Standard statistic is also given. This is the annual fourth-highest daily 8-hour average ozone concentration. Monthly means and extremes are shown in Appendix II.

Exceedances of the 1-hour ozone objective, 2003 (number of hours)													
Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Blissville						1							1
Campobello [s]													0
Canterbury													0
Customs													0
Forest Hills													0
Fredericton													0
Fundy Park		M	M	M	M	14	6	5		M	M		25
Hillcrest													0
Lower Newcastle													0
Mobile (Lameque)	-	-	-	-	-						-	-	0
Moncton								1					1
Norton							1						1
Pt. Lepreau													0
St. Andrews													0
St Leonard													0
Total	0	0	0	0	0	15	7	6	0	0	0	0	28

The 1 hour National Objective is 82 ppb. The Campobello site is operated in summer only. M = missing data.

A. Smog Advisories

DELG works with Environment Canada and the Department of Health and Wellness in the preparation and dissemination of daily forecasts of ozone. NBDELG maintains the monitoring network and supplies real-time data to Environment Canada forecasters, who issue twice-daily forecasts of ozone concentrations. When forecast data indicate that the 1-hour National Air Quality Objective for ozone will be exceeded or closely approached, air quality and health advisories are issued to the media to provide advance notice to the public. Advisories may be issued for specific regions of the province.

In 2003, an air quality and health advisory was issued for all regions of the province on June 26 at 1500. This ozone episode affected primarily southern areas, with exceedances noted at Fundy Park on the 27th and 28th and Blissville on the 27th. The smog

Number of hours with 8-h average above 65 ppb and Annual CWS Statistic, 2003														
Site	J	F	M	A	M	J	J	A	S	O	N	D	Total	CWS Statistic (ppb)
Blissville						11							11	56.4
Campobello Isl.						3							3	59.0
Canterbury													0	57.1
Customs													0	52.8
Forest Hills						1							1	57.4
Fredericton														60.0
Fundy Park					14	78	26	35					153	Invalid
Hillcrest								4					4	61.8
Lower Newcastle						2							2	62.1
Mobile (Lameque)	-	-	-	-	-	4	5				-	-	9	Invalid
Moncton							2	9					11	64.5
Norton						12	12	6					30	70.1
Pt. Lepreau													0	60.4
St. Andrews						8	6						14	65.0
St Leonard						3							3	61.4
Total					14	118	46	54					241	

The Canada Wide Standard is 65 ppb averaged over 8 hours.

advisory was continued for most areas on the 27th and 28th, then ended on June 28 . This episode featured high temperatures, with a flow of air from the south, crossing New England. Peak ozone readings were on June 26, when 110 ppb was recorded at Fundy Park. Although no further smog advisories were issued during 2003, there were several additional periods when elevated ozone concentrations affected the province. In July, ozone events were noted on the 3rd and 21st at Fundy Park, with peak hourly readings of 108 ppb and 85 ppb, respectively. Norton recorded 83 ppb on July 3.

In August, readings peaked at 82 ppb at Fundy Park on the 16th. On the 22nd, a peak reading of 93 ppb occurred at this site. Just prior to the latter event, on August 20 many areas of the province were affected by regional haze due to forest fire smoke, originating in Manitoba and northern Ontario. This particulate pollution continued through to August 22.

12. ACID PRECIPITATION NETWORK

New Brunswick has operated an extensive precipitation chemistry network since the early 1980s. Since 1987 this has been a partnership effort, with logistical and financial support from NB Power. In 2003 there were 13 stations operating and they are predominantly located in rural areas. All precipitation samples are analysed at the NBDELG laboratory, and DELG staff co-ordinate the monitoring program, perform data quality assurance, and maintain the official data archive.

The potentially adverse impacts of acid precipitation have been recognised for more than 20 years. Acid rain effects are felt regionally, not just close to the sources of contaminants themselves. The emissions which cause acid precipitation (primarily sulphur and nitrogen oxides) typically travel long distances - hundreds or even thousands of kilometres - before returning to the surface in rain or snow. The same emissions also contribute to regional haze and fine particulate pollution.

Precipitation chemistry in New Brunswick is affected by local emissions and the emissions from several large industrial regions which lie upwind, including the American midwest, southern Ontario and Québec, and the Washington-Boston region.

Partly because the site of impact can be remote from the point of emission, no standards have been put in place for acid precipitation, although the province does have an ambient air standard for SO_2 along with a provincial emission cap for SO_2. Instead, the issue has been managed by the adoption of 'target' or 'critical' loads. These are similar to the objectives used in the management of other air pollutants, such as NOx. Although they are not legally enforceable, they do provide a goal towards which affected US States and Canadian Provinces are working, as emissions are reduced over time.

The severity of acid rain impact is generally measured by computing how much sulphate (a measure of sulphuric acid) falls on each hectare over one year. The target load for acid rain is expressed in terms of this amount of sulphate. In the late 1980s, the proposed target load for eastern Canada was 20 kilograms per hectare per year (kg/ha/yr). This target was initially designed to provide protection to areas which are moderately sensitive to acidification. This sensitivity varies in different areas, because geological characteristics such as soils and bedrock have different abilities to neutralise the acid precipitation. This is often referred to as the 'buffering capacity'.

Over time, scientists realised that these initial target loads were not adequate to provide long term protection, or protect more sensitive watersheds. The newer concept of critical loads was introduced in the 1990s. Critical loads take into account the nature of individual watersheds, and are calculated to ensure long-term protection from acidification.

Critical loads for acidification in New Brunswick range from less than 8 up to 11 kg/ha/year of sulphate input (referred to as acid sulphate deposition). The lowest values of less than 8 kg/ha/yr are found in the most sensitive areas that typically have granite bedrock (e.g. areas of southwestern and central northern New Brunswick), and 11 kg/ha/yr in most of the rest of the Province.

In recent years, acidic deposition has been declining slowly. This means that the critical load values are beginning to be met over some parts of the Province, although still exceeded in others, notably the sensitive regions in the southwest. There is, however,

still more effort required to reduce acid deposition further and ensure that the more sensitive lakes and rivers, such as those in southwestern N.B., are provided with long term protection from acid damage. Further cuts in sulphur dioxide emissions are being pursued, both in the Province and those regions of eastern Canada and the United States which are the main source regions of these acid-causing emissions.

Figure 13 shows the location of monitoring sites, and Figure 14 the acid deposition recorded in 2003.

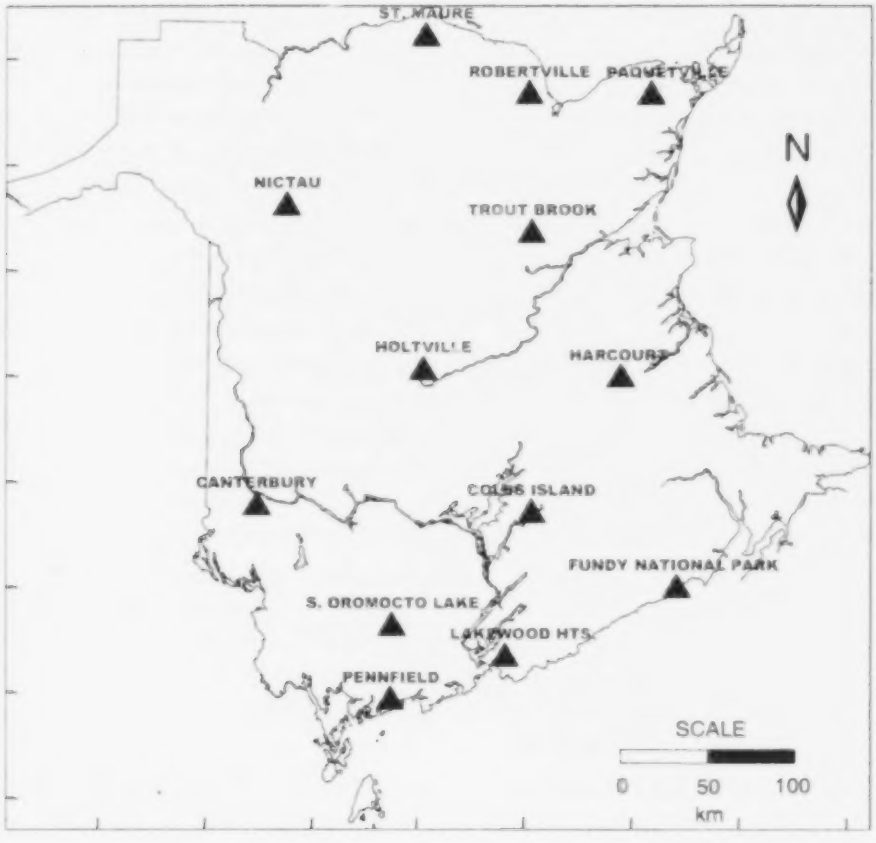


Figure 13. Location of acid rain monitoring sites in New Brunswick (2003).

Acid deposition values in 2003 were similar or lower at most stations than in 2002. The greatest acid deposition was observed at Fundy Park and Lakewood Heights, in east Saint John. Sulphate concentrations at Lakewood Heights were also the highest in the provincial network. In 2003, total annual precipitation was about 10% above normal in the west of the province, and about 10% below normal in eastern, northeastern and southern areas.

Acid deposition, the total amount of a chemical substance entering the environment, is a factor of both concentration in the precipitation and the amount of precipitation received. As a result, there will always be significant variability in acid deposition between years due to variability in

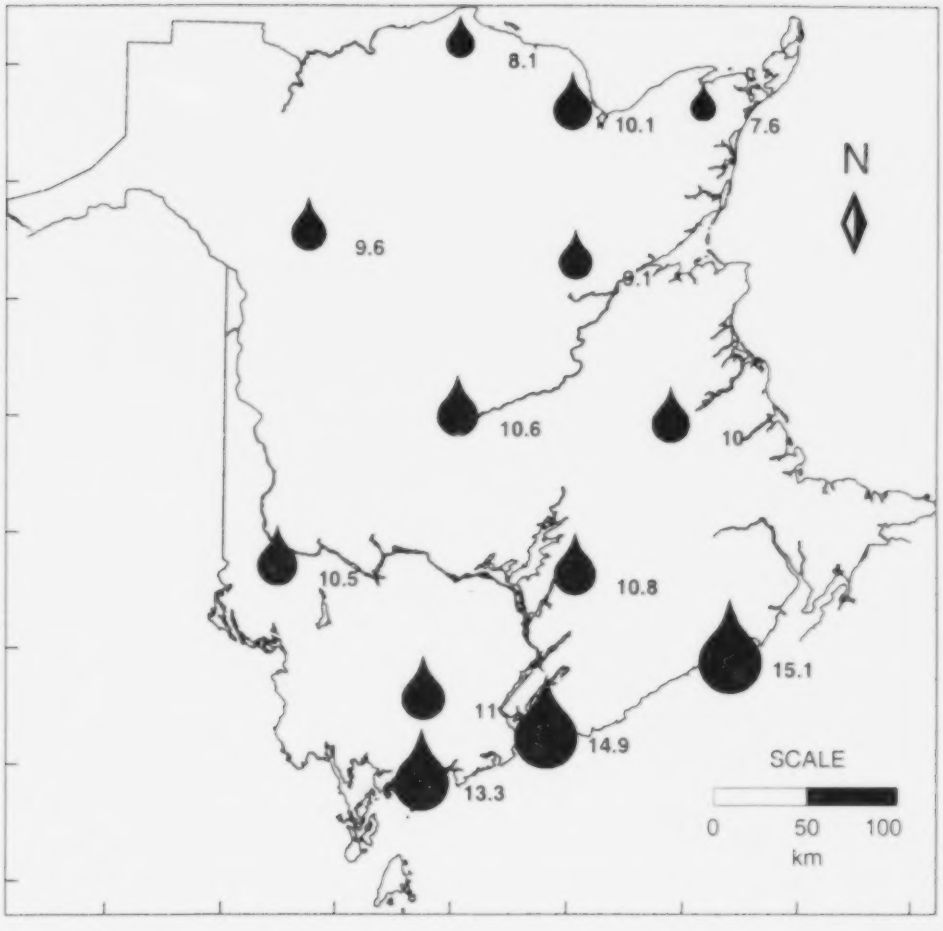


Figure 14. Acid deposition for 2003 (kilograms per hectare per year of sulphate).

The droplet symbols are sized in proportion to the deposition measured at that site.

weather patterns. Results presented in the following section on long term trends indicate that when averaged across the province, the concentration of acidic pollutants in precipitation (which is less dependent of the amount of precipitation received) appears to be falling. Although encouraging, the data also show that the acid rain issue remains important in New Brunswick, as critical loads for acid rain continue to be exceeded, especially in the south. This remained true in 2003. Although deposition values were relatively low, critical loads were still exceeded in most areas.

A. New England Governors/Eastern Canadian Premiers Acid Rain Action Plan

Since the early 1980s the New England Governors/Eastern Canadian Premiers (NEGECP) have met annually to discuss items of regional interest, such as trade, tourism and the environment. In the 1980s and early 1990s this collaboration led to significant efforts to address the acid rain issue, and develop emission control programs.

The NEGECP held their 2003 annual meeting in Groton, Connecticut, in September. A Resolution was passed encouraging the use of cleaner diesel fuels, pursuing options to reduce diesel emissions, promoting anti-idling initiatives, and a strategy enhancing public education on the benefits of cleaner diesel options. The Resolution also addressed energy efficiency initiatives and renewable energy.

A number of reports were also presented at the September meeting, including reports on acid rain, climate change and mercury projects, and biotechnology.
Additional details are available at: http://www.cap-cpma.ca/

B. Canada-Wide Acid Rain Strategy for Post-2000

In October 1998, this strategy was signed by the Ministers of Environment and Energy of all provinces and territories. The Post-2000 Strategy updates efforts which have been going on since the mid 1980s to reduce emissions which contribute to acid rain. Efforts from 1985 to date have reduced sulphur dioxide emissions in eastern Canada by 50% from 1980 levels. The Post-2000 strategy contains plans to reduce acid-causing emissions even further, recognising that although progress has been made, more reductions are still needed to enable critical loads to be reached. The strategy also provides direction for other activities such as scientific monitoring and research, and it makes a formal commitment to seek further reductions in sulphur dioxide emissions from the United States. The Strategy addresses pollution prevention, specifically "keeping clean areas clean", aims to ensure the adequacy of acid rain science and monitoring programs, and reports on SO_2 and NOx emissions and forecasts.

Work commenced on the 2004 Acid Rain Science Assessment, scheduled for release in February 2005. The previous assessment was completed in 1997. Two workshops were held in Montreal during the course of the year, bringing together acid rain experts within Canada to share their knowledge of acid rain, to discuss the content of the 2004 Assessment, and to discuss future acid rain research in Canada. In conjunction with the second workshop on the 2004 Science Assessment held in Montreal, a workshop took place to share the current state of knowledge of acid deposition modelling, the current understanding of nitrogen dynamics in watersheds, and how such dynamics can be simulated by models.

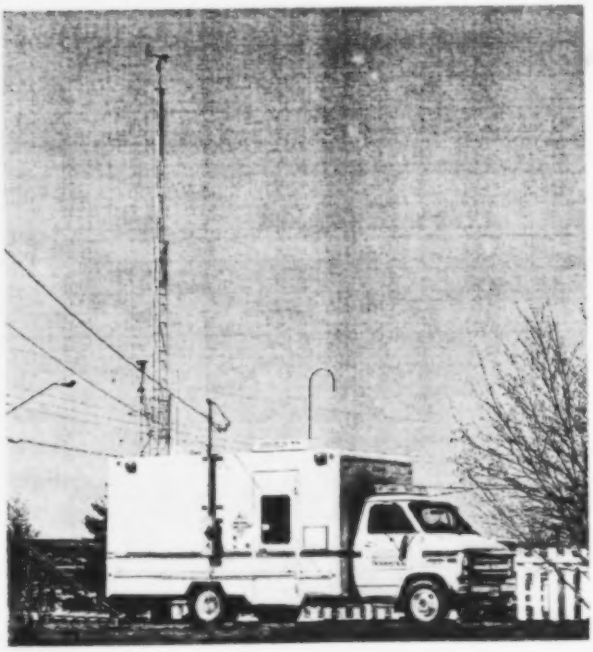
The 2002 Annual Progress Report on the Canada-Wide Acid Rain Strategy for Post-2000 was published in December 2003.

DELG and Environment Canada staff jointly authored a scientific paper published in the October 2003 edition of Environmental Monitoring and Assessment, entitled "Changes in Acid Precipitation Related Water Chemistry of Lakes from Southwestern New Brunswick, Canada, 1986-2001". The paper reports that while acid deposition has declined and some lakes are showing signs of recovery, a large proportion of lakes in southwestern New Brunswick remain acid sensitive.

As part of a National Lake Monitoring Program, Environment Canada has been monitoring ten lakes in southwestern NB twice yearly (spring and fall) since 2000. In the fall of 2003, EC also sampled ten lakes in north-central NB. The north-central lakes will not be sampled again in 2004, but the sampling of the southwestern lakes will continue.

13. MOBILE AIR QUALITY MONITORING UNIT

To help in evaluating air quality in New Brunswick, the Department of the Environment and Local Government has developed a mobile air quality monitoring unit. It augments monitoring carried out at established monitoring sites and can be moved to most areas of the province, fulfilling temporary monitoring needs. The vehicle is presently able to measure the following pollutants: sulphur dioxide, nitrogen oxides, ozone, total reduced sulphur (including hydrogen sulphide) and fine particulate matter (PM_{10} or $PM_{2.5}$). The vehicle is also fitted with a retractable 10 metre mast with wind speed and direction instruments



The mobile air monitoring vehicle is being used in the following applications:

- Assessment of the local impact of point or area emission sources
- An evaluation tool in responding to local air quality issues
- Site evaluation prior to establishing a permanent monitoring site
- Comparative analysis studies with permanent monitoring sites
- Validation of predictive air quality modelling studies
- Determination of background or baseline air quality
- Investigating a planned or sustained event that has potential for air quality impacts, e.g. slash burning, forest fire, fire training exercise.

2003 Operations

During 2003, the mobile unit was operated from February 28 to May 21 at the Irving Oil Refinery in east Saint John, in an area at the south of the complex in the construction parking lot, off Grandview Avenue.

From June 3 until October 28, the unit was operated in the community of Lamèque, in the Acadian peninsula, to investigate concentrations of reduced sulphur compounds.

In November and December, the unit was in Fredericton for servicing.

Monitoring results are summarized in the following tables. When interpreting the results, attention should be paid to the amount of time that monitors were operating in each month (indicated as "coverage" in the data tables).

A. Saint John - Irving Oil Refinery

Monitoring was conducted from February to May at the construction parking area in the southern part of the refinery complex. This was to further investigate air quality in this vicinity and extend a period of special monitoring begun in 2001. No exceedances were logged for SO_2, NO_2 or TRS during the monitoring period. Some SO_2 impacts were apparent at the monitoring location, with values exceeding 50 ppb quite often in March and April. TRS levels were low. NO_2 concentrations were indicative of relatively constant, medium to low level impact, with levels fluctuating between 10 and 30 ppb. $PM_{2.5}$ results were quite low, seldom exceeding 20 micrograms per cubic metre as an hourly average.

B. Lamèque

The mobile unit was stationed at Lamèque through the summer and into fall, 2003. There were exceedances of the 1-hour and 24-hour objectives for H_2S from July to October. High TRS readings were found to correlate with periods of low tide, when decomposing seaweed is exposed to the air. TRS concentrations were highest in July and August, decreasing in September and October, with the arrival of cooler weather. As in 2002, procedures were put in place in August to provide up-to-date air quality data to the community and the Department of Health and Wellness. This was accomplished by the use of automated reports sent via email, and the reporting of an

Mobile Monitoring Unit – Data Summary 2003
Saint John, Irving Oil Refinery, Construction Parking Area

	Feb	Mar	Apr	May
SO_2				
Coverage (%)	2	85	96	63
1-h exceedances (>170 ppb)	0	0	0	0
24-h exceedances (>56 ppb)	0	0	0	0
Peak 1-hour value (ppb)	7	118	96	43
Monthly mean (ppb)	-	8	4	2
TRS				
Coverage (%)	2	85	96	63
1-h exceedances (>11 ppb)	0	0	0	0
24-h exceedances (>3.5 ppb)	0	0	0	0
Peak 1-hour value (ppb)	0	3	11	7
Monthly mean (ppb)	-	1	0.4	0.5
NO_2				
Coverage (%)	2	86	100	65
1-h exceedances (>210 ppb)	0	0	0	0
24-h exceedances (>105 ppb)	0	0	0	0
Peak 1-hour value (ppb)	8	35	39	25
Monthly mean (ppb)	-	10	7	4
$PM_{2.5}$				
Coverage (%)	2	84	100	65
Max 24-h average (micrograms/cubic metre)	10.6	36.0	26.4	19.0
Monthly Mean (micrograms/cubic metre)	-	6.0	5.2	3.7

Mobile Monitoring Unit – Data Summary 2003 Lamèque, rue du Rivage						
		June	July	Aug	Sep	Oct
SO_2						
Coverage (%)		87	96	96	96	86
1-h exceedances (>340 ppb)		0	0	0	0	0
24-h exceedances (>113 ppb)		0	0	0	0	0
Peak 1-hour value (ppb)		29	33	40	52	25
Monthly mean (ppb)		1	2	2	4	1
TRS						
Coverage (%)		45	73	96	96	86
1-h exceedances (>11 ppb)		0	89	28	7	1
24-h exceedances (>3.5 ppb)		0	249	133	45	0
Peak 1-hour value (ppb)		5	135	111	44	11
Monthly mean (ppb)		0	7	2	1	1
NO_2						
Coverage (%)		91	99	99	100	90
1-h exceedances (>210 ppb)		0	0	0	0	0
24-h exceedances (>105 ppb)		0	0	0	0	0
Peak 1-hour value (ppb)		7	3	3	2	5
Monthly mean (ppb)		2	0	0	0	0
O_3						
Coverage (%)		44	100	100	100	90
1-h exceedances (>82 ppb)		0	0	0	0	0
Peak 1-hour value (ppb)		73	73	64	56	50
Monthly mean (ppb)		38	34	25	29	30
PM_{10}						
Coverage (%)		91	92	93	97	84
Max 24-h average (micrograms/cubic metre)		53.8	24.0	31.9	30.7	17.3
Mean (micrograms/cubic metre)		14.3	12.7	10.0	10.5	5.7

Note: "coverage" means the percentage of the hours in each month for which valid data were obtained.

air quality index, made available via a local phone number as part of the weather forecast information service. The Department of Health and Wellness also issued a media statement in July, explaining the possible health effects of high TRS concentrations.

There were no recorded exceedances for SO_2, NO_2 or ozone. PM_{10} values were generally moderate. At the end of June, during a regional smog episode that affected much of the province, there were two days when the 24-h average exceeded 50 micrograms per cubic metre.

14. LONG TERM AIR POLLUTION TRENDS

In addition to examining air quality monitoring results for a given year, it is often informative and revealing to compare annual results to previous years, and consider longer term trends. This provides information on how air quality may be changing over the years, and whether emission control measures as applied to industrial operations and consumer products (notably vehicles) are influencing long term environmental quality. As mentioned in the introduction, air quality monitoring has been ongoing in parts of the province since the 1970s, especially in the Saint John region. In this section, data for key locations with long-term records are presented to provide information on air quality trends.

A. Carbon Monoxide

The only long term site for this substance is the Customs Building site in uptown Saint John. The earlier part of the record (prior to 1991) is from the nearby Post Office location. Results are predominantly influenced by motor vehicle emissions. Results show that since 1980, the annual average has changed relatively little. There are signs of a possible decrease from 1980 to the mid 1990s, and an increase since then, although the variability between years reduces the confidence that these are meaningful patterns. During the period in question the population of Saint John has increased approximately 4% (Aldighieri, 1998). The number of vehicles registered and more notably, the average total kilometres driven each year, have been increasing throughout the 1990s (Goggin, 1999; Transport Canada, 1999; Statistics Canada, 1999). These pressures, which tend to increase carbon monoxide emissions, have been offset by a greater proportion of vehicles fitted with emissions control equipment, such as catalytic converters. In 2003, results were similar to those over the past few years.

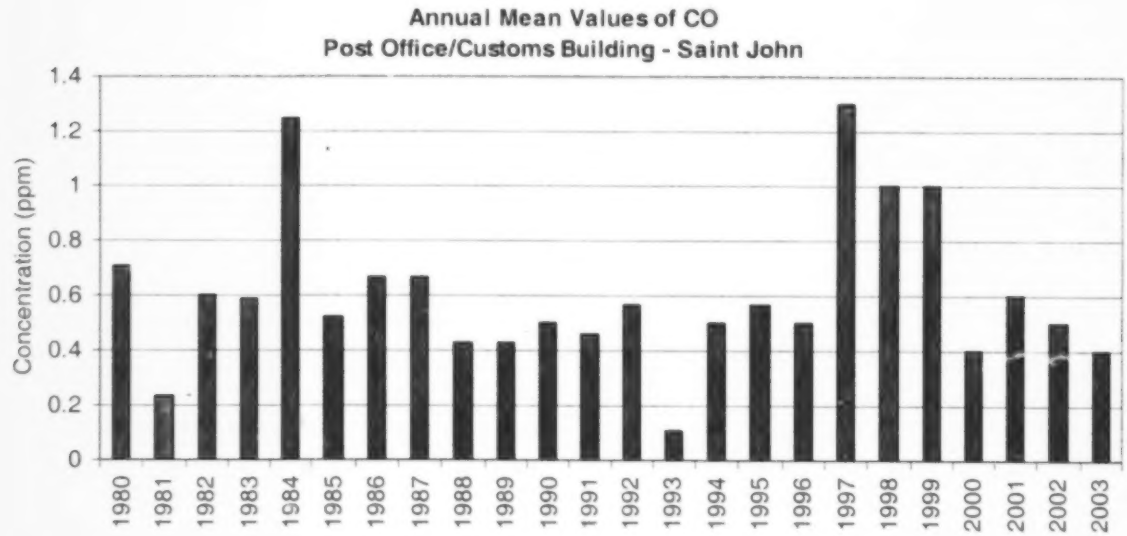


Figure 15. Annual mean values of carbon monoxide, Post Office/Customs Building, Saint John, 1980-2003.

Fredericton and Moncton

The record to date at these stations shows values similar to those recorded at the Saint John-Customs location, with the Moncton site having higher values. This may be a reflection of the influence of local sources such as the Université de Moncton heating plant, or proximity to the ring road. Results in 2003 were lower than those in the previous 3-4 years.

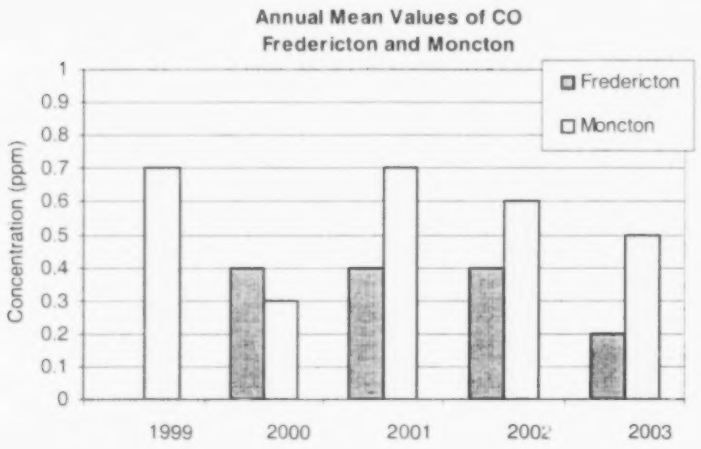


Figure 16. Annual mean values of carbon monoxide, Fredericton and Moncton, 1999 -2003.

B. Nitrogen dioxide

Forest Hills

Nitrogen dioxide is another key pollutant emitted by motor vehicles, as well as industrial sources. The trend at Forest Hills, in suburban east Saint John, appears to be downward since 1981, with some variation about a mean of approximately 5 ppb.

Forest Hills is influenced by emissions from local industries as well as the more diffuse sources such as vehicles.

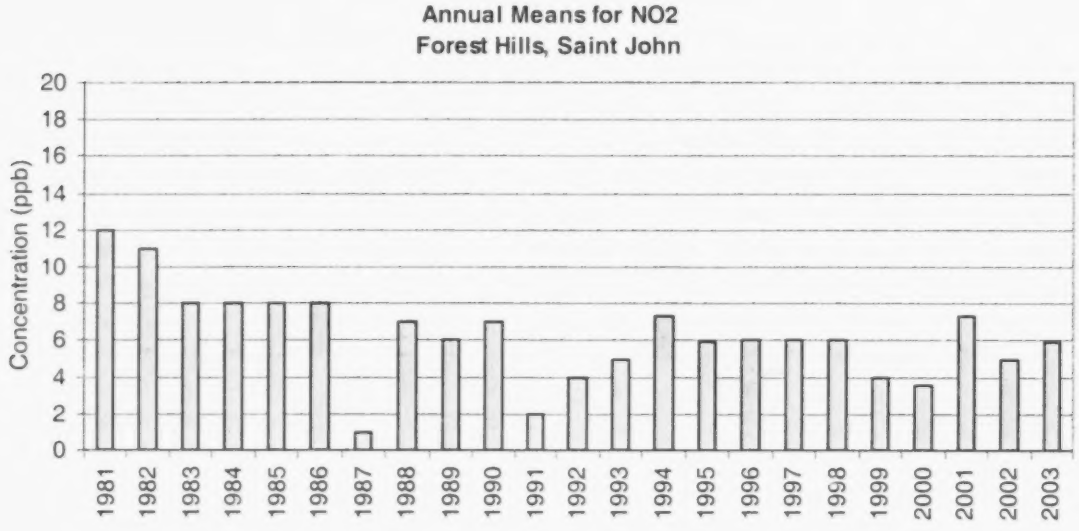


Figure 17. Annual mean nitrogen dioxide at Forest Hills, Saint John, 1981-2003.

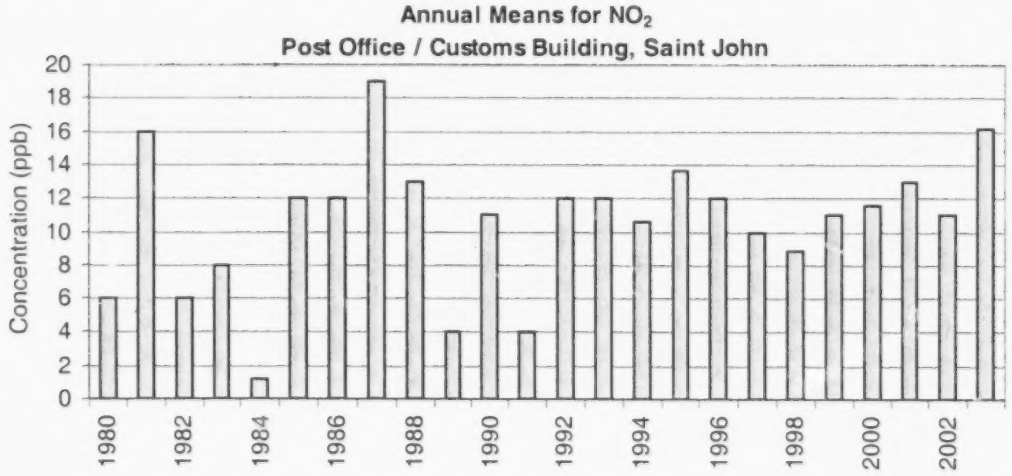


Figure 18. Annual mean nitrogen dioxide at Customs Building, Saint John, 1980-2003.

Customs Building

In 2003, the annual mean at this uptown location was higher than values in recent years. This may be due to increased cruise ship traffic in the nearby harbour, as well as construction activity in the vicinity of the monitoring site.

Fredericton and Moncton

The record for these centres is short, but is presented for comparison. NO_2 values appear to be higher on average at the Moncton station. 2003 results were similar to those in 2001 and 2002.

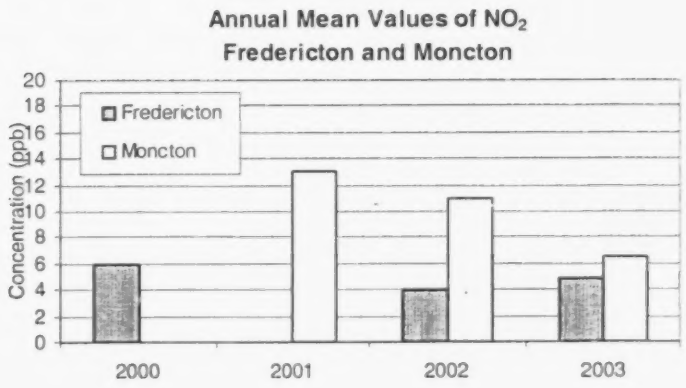


Figure 19. Annual mean nitrogen dioxide at Fredericton and Moncton, 2000-2003.

C. Sulphur dioxide

Forest Hills

Air quality monitored at the Forest Hills site in east Saint John is influenced by several local industries. Considering the trend since 1976, annual average concentrations have increased and decreased several times over the 22 year period, from 1976 to 1987 and from 1987 to 1996. In 2003, values were similar to those seen over the past 10 years.

Influences on sulphur dioxide levels at this site include emissions from the Courtenay Bay generating station, the pulp and paper sector, the oil refinery and the Coleson Cove generating station.

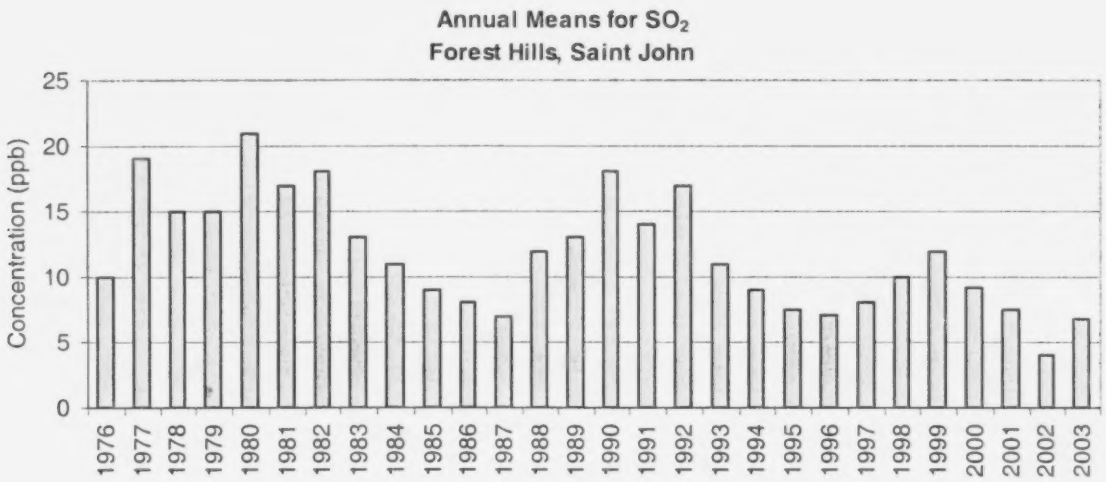


Figure 20. Annual mean sulphur dioxide at Forest Hills, Saint John, 1976-2003.

Customs Building

In uptown Saint John, as represented by records from the Post Office and Customs Building sites, the sulphur dioxide trend has been downward since the mid-1970s. Recently, levels have been approximately 30% of those common in the early 1980s. Decreasing concentrations in this part of the city are probably due to reduced emissions from the Reversing Falls pulp and paper mill, which fell by about 70% from 1980 to 1995. Reduced emissions from the NB Power Courtenay Bay generating station (down 74% from 1990 to 1995) may also be partly responsible. The annual mean in 2003 was the lowest in the record so far, continuing a downward trend since 1999.

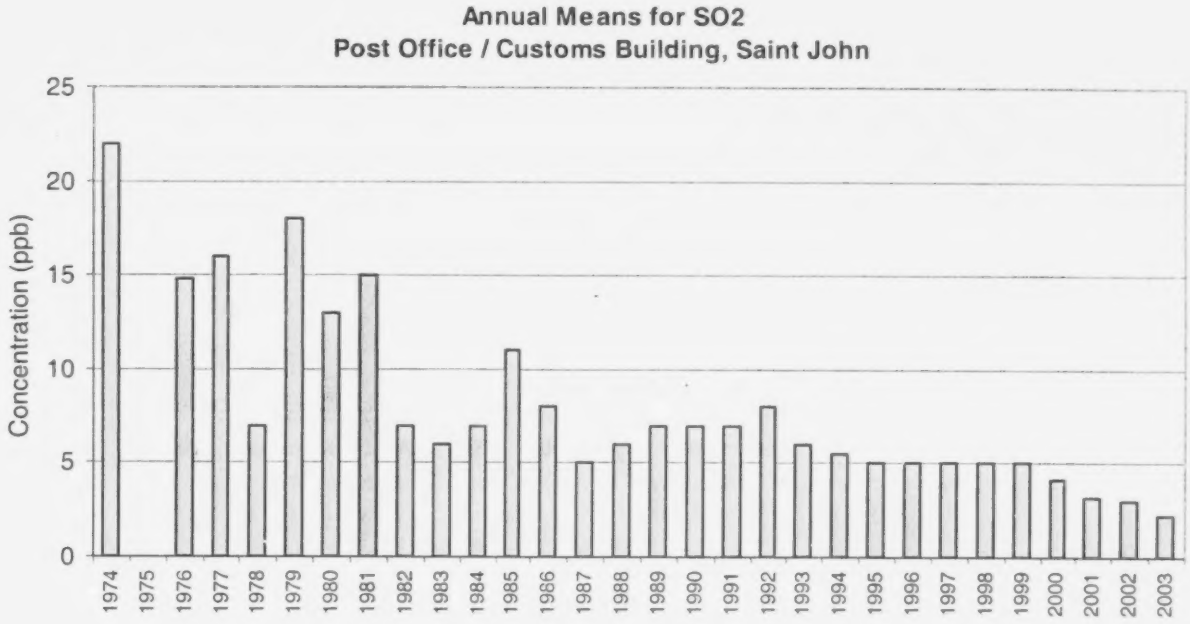


Figure 21. Annual mean sulphur dioxide at Post Office/Customs Building , Saint John, 1974-2003.

Saint John – All sites

To examine the recent trend city-wide, a composite average of all sites in the Saint John network was calculated. This trend is shown in Figure 22. Four sites were operating in 1993-94, and seven sites 1995-2003.

This statistic shows a downward trend from 1997 to 2002, but increased in 2003. Increases were seen at three sites, all in east Saint John. In addition, values recorded at the new Paper Mill Pond site south of the refinery were the highest in the network (exceeding the annual objective), which drove up the overall average.

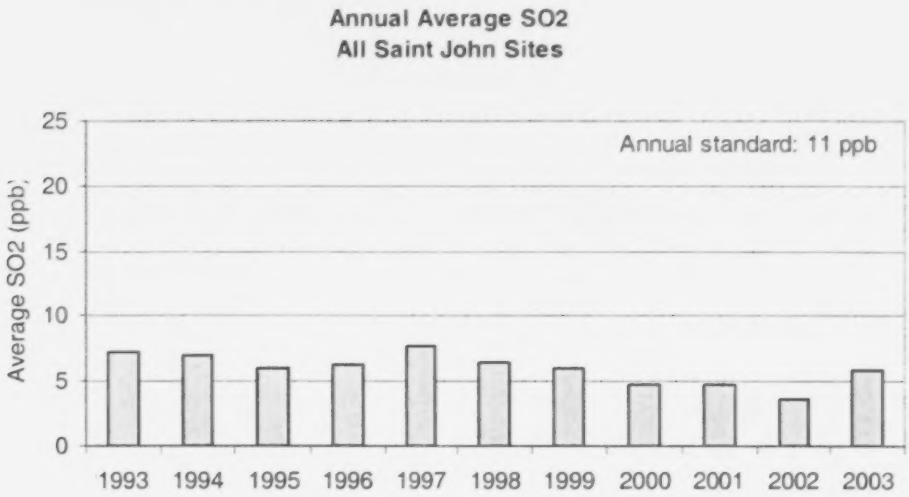


Figure 22. Trend in sulphur dioxide in Saint John: annual network average 1993-2003.

D. Ozone

As explained in section 11, ozone is a regionally transported pollutant which is not emitted directly from smokestacks or tailpipes, but which forms in the air when other pollutants mix and react together. As such, trends in ozone are due to changing emissions of the pollution ingredients that are required for ozone to be made (nitrogen oxides and volatile organic compounds) over a large upwind area of eastern Canada and the United States. Seasonal weather, especially summer conditions, also has a major influence on the amount of ozone affecting New Brunswick.

Forest Hills

At Forest Hills, ozone levels have not changed significantly over the past 19 years. There have been some years such as 1984 and 1988 which had higher values, but there is no overall trend either up or down. Results in 2003 were higher than for the preceding five years.

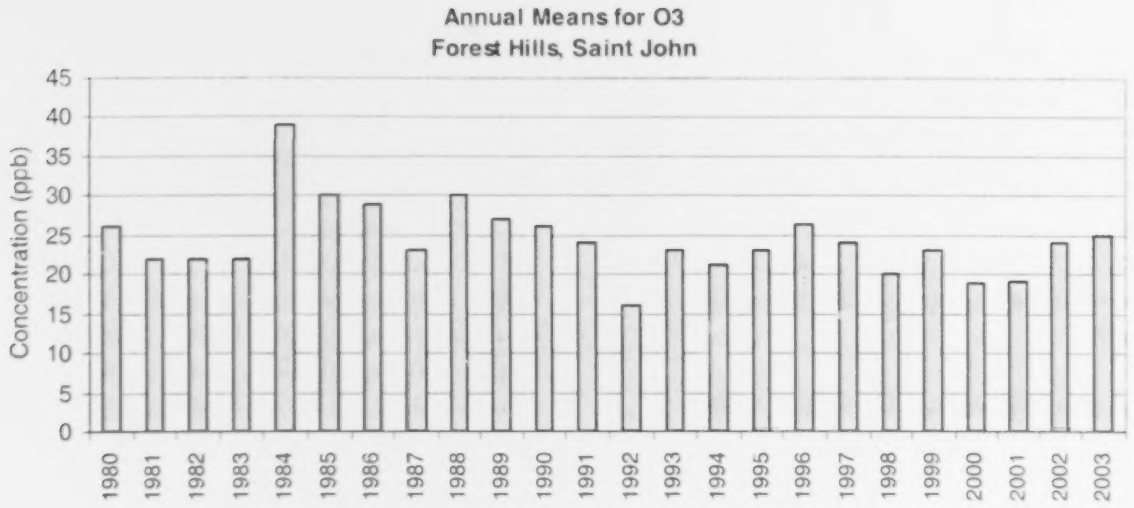


Figure 23. Annual mean ozone at Forest Hills, Saint John, 1980-2003.

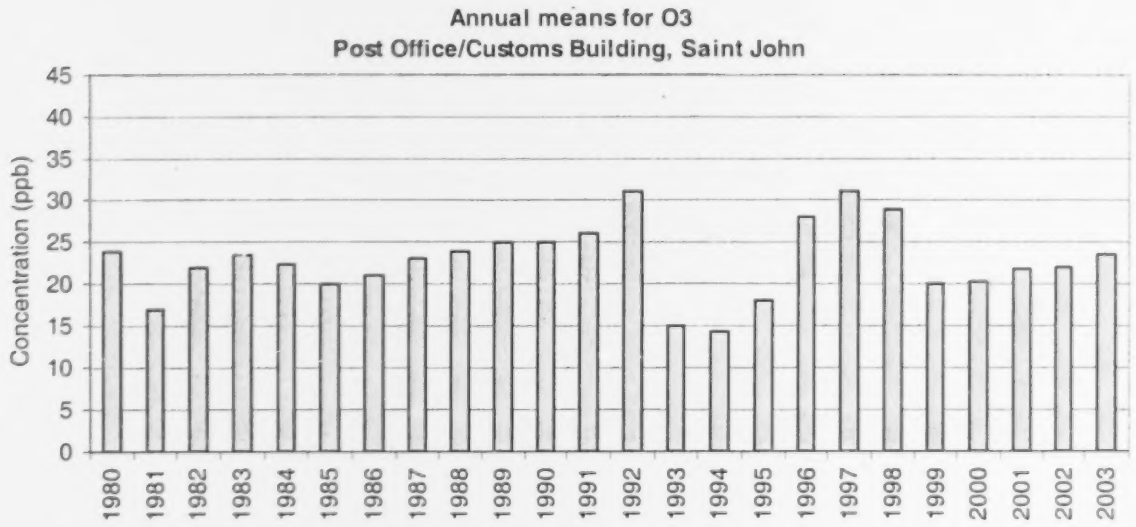


Figure 24. Annual mean ozone at Post Office/Customs Building, 1980-2003.

Customs Building

At the Customs site, annual averages for ozone have been variable since the early 1990s. Taking the most recent results into account, there is no clear trend to be seen over the period of record. However, as at Forest Hills, the 2003 results were higher than those seen over the last few years.

Point Lepreau

Data for this site are included to provide a perspective from a rural location which is almost always upwind of major sources of air pollutants in southern New Brunswick. Annual ozone levels are somewhat higher than those seen in the Saint John area. This is due to the lack of other emissions which react with and remove ozone from the air (mainly nitric oxide).

The record at Point Lepreau reveals considerable variability between years and the indication of a possible upward trend since 1986. The 2003 results were similar to those of recent years.

Due to the complex relationship between ozone, its precursor compounds and weather conditions, it is very difficult to evaluate the significance of apparent trends in ozone. Within a given geographic area it is not unusual to find different trends at different sites, even though all may be apparently influenced by the same weather and pollution transport conditions. Local site factors are probably important.

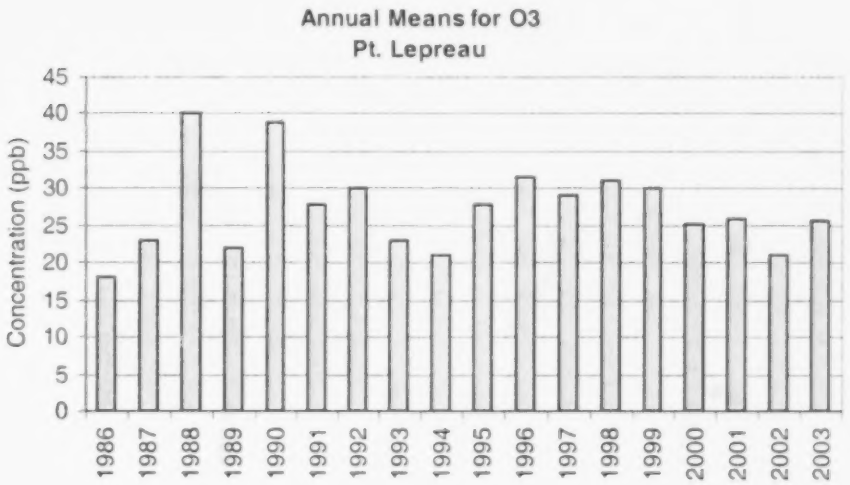


Figure 25. Annual mean ozone at Point Lepreau, 1986-2003.

Provincial ozone trends

Figure 26 shows a composite trend based on all ozone sites in the province. The number of sites has increased substantially over the period of record, from two initially, to 13 in 2000. The latter half of the record is therefore more meaningful. This analysis of the data also suggests that there is no apparent trend in ozone concentrations, with annual averages close to 25 ppb being the norm.

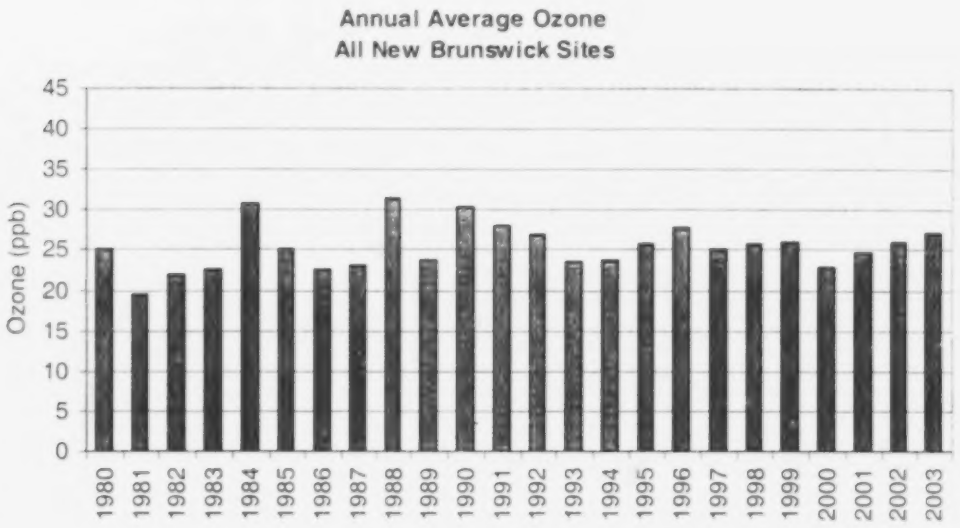


Figure 26. Annual average ozone concentrations based on all New Brunswick sites, 1980-2003.

E. PM_{10}

This section presents results obtained using high volume samplers.

Provincial Building

The long-term trend in PM_{10} for this site is shown in Figure 27. The annual mean for 2003 was relatively low in comparison with the long-term average.

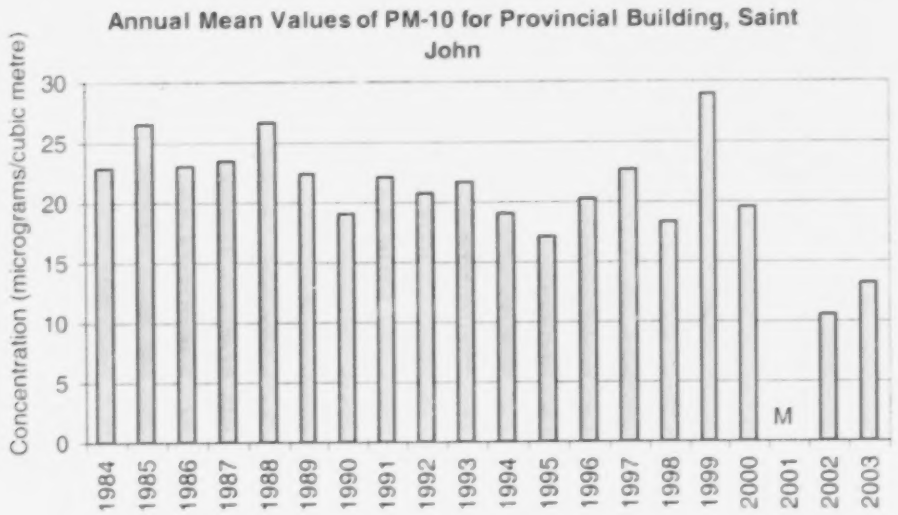


Figure 27. Annual mean PM_{10} at Provincial Building, Saint John, 1984-2003.
M = missing data.

F. Acid Rain

Since 1986, 27 separate sites have been operated for monitoring acid deposition across New Brunswick. Provincial coverage is presently maintained with 13 sites.

To provide a statistic which can give some indication of long term changes or trends, the annual average sulphate concentration in precipitation was averaged across all sites operating in each year. The results are shown in the accompanying chart, which also shows the number of sites operating in each year. The trend is downward since 1989. This is expected, based on reductions in sulphur dioxide emissions in eastern Canada and the United States in the same time period.

In 2003, the provincial average sulphate concentration was the lowest yet recorded, slightly below the previous low, set in 1995.

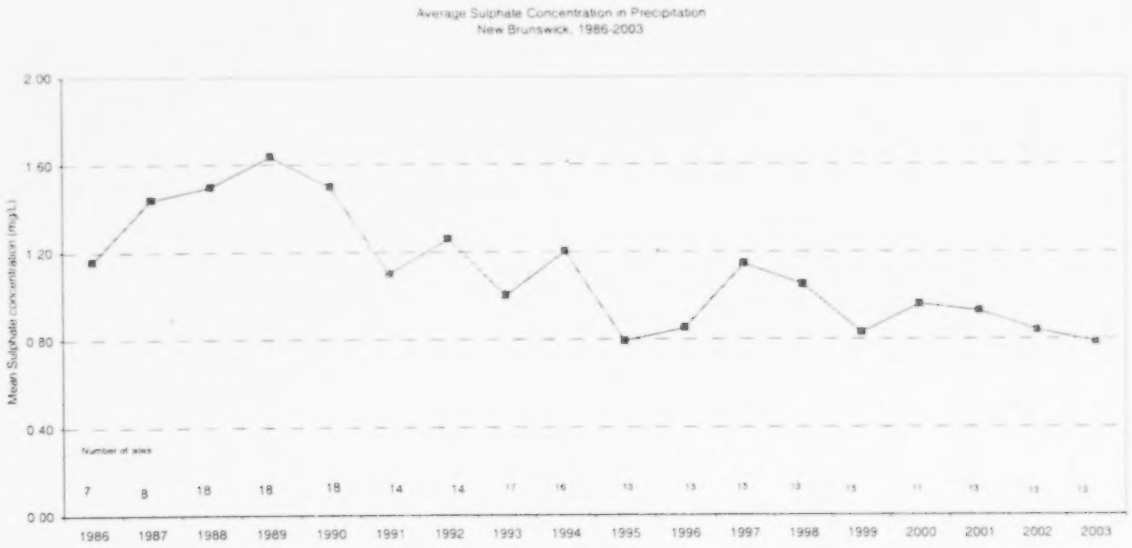


Figure 28. Network-wide mean annual sulphate concentration in precipitation in New Brunswick, 1986-2003.

G. Volatile Organic Compounds

VOCs have been measured at two locations (Forest Hills and Point Lepreau) since 1992, as noted in section 10. Routine analyses provide results for over 150 VOCs. In July 2000, sampling was begun at Champlain Heights School in east Saint John. Trends for selected VOCs are presented in this section.

One clear finding of the VOC sampling program is that concentrations of most VOCs are substantially higher at Forest Hills and Champlain Heights than at Point Lepreau. This is consistent with the location of Forest Hills in an industrial urban setting and Point Lepreau in a relatively remote, rural situation.

Figure 29 shows trends in average total VOC concentrations for all sites since 1992.

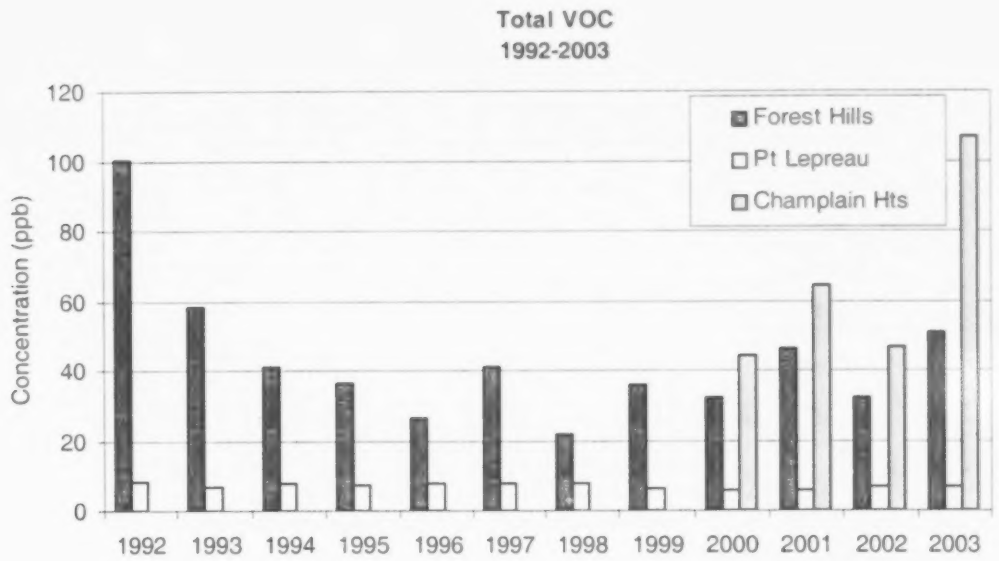


Figure 29. Average total VOC concentration at provincial VOC monitoring sites, 1992-2003.

These results clearly show the difference in average VOC levels between the sites. At Forest Hills, total VOC concentrations decreased from 1992 to 1998, and have risen slightly since then. There has been relatively little change at Point Lepreau.

Total VOC concentrations in 2003 increased at both Forest Hills and Champlain Heights, compared with 2002. Emissions from the refinery complex clearly influence both locations. Compounds such as butane and isopentane, which are major components of gasoline vapour, generally reflected the total VOC trend (Figure 30). Results from Champlain Heights showed values about double those recorded at Forest Hills, with 2003 results higher than 2002. At Point Lepreau, butane + isopentane values in 2003 were similar to those in 2002, whereas values at Forest Hills almost doubled, and at Champlain Heights, values more than doubled.

Some potentially toxic VOCs decreased from the early to the late 1990s, and have been more variable since then. Figure 31 shows the trend for benzene, Figure 32 for butadiene and Figure 33 for xylenes. In each case there is little apparent trend at the rural Lepreau site.

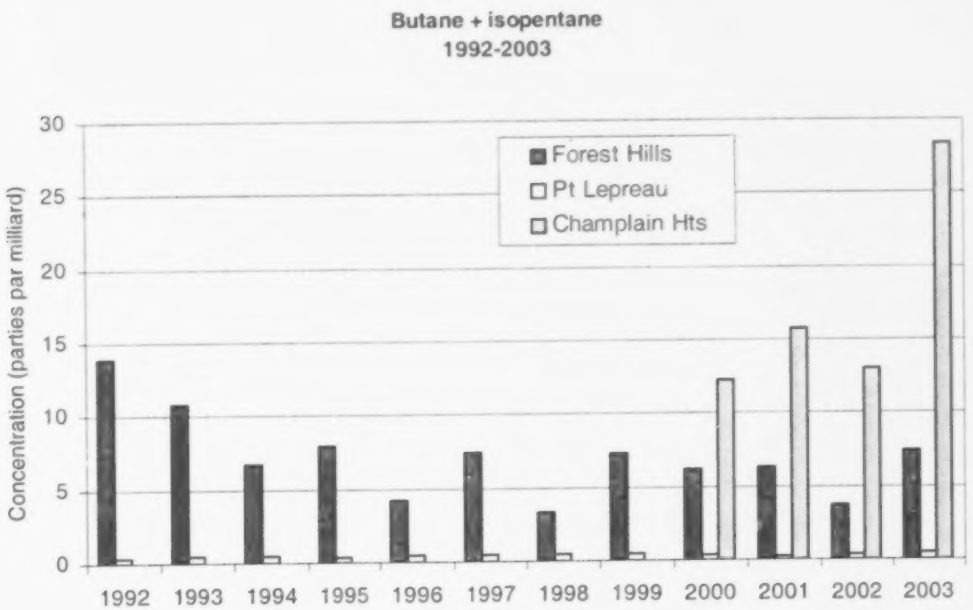


Figure 30. Annual average concentration of butane plus isopentane at provincial VOC monitoring sites, 1992-2003.

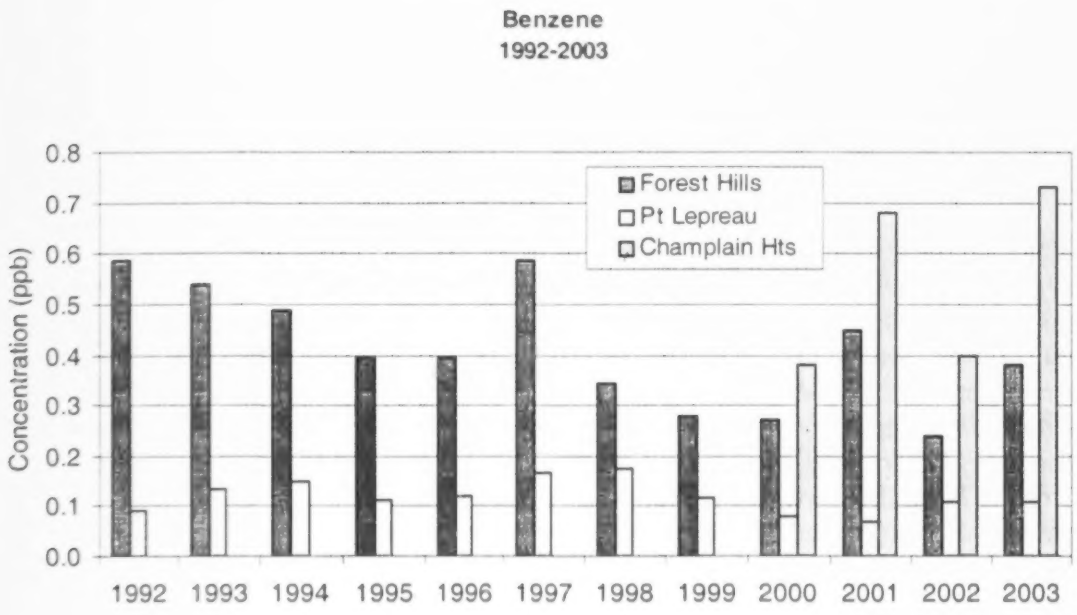


Figure 31. Annual average concentration of benzene at provincial VOC monitoring sites,1992-2003.

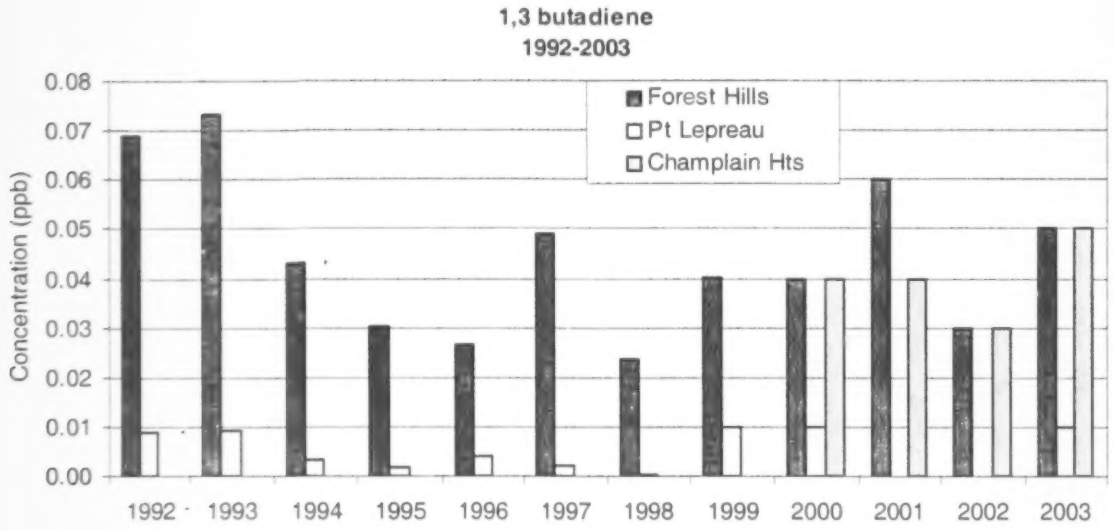


Figure 32. Annual average concentration of 1,3 butadiene at provincial VOC monitoring sites, 1992-2003.

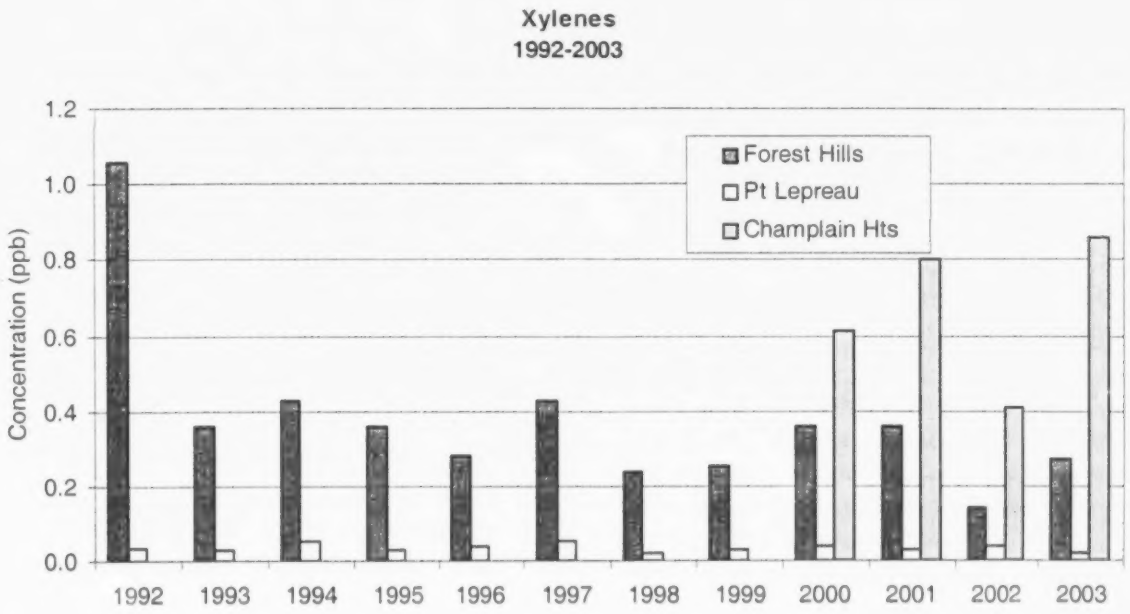


Figure 33. Annual average concentration of xylenes at provincial VOC monitoring sites, 1992-2003.

Benzene is an important component of gasoline. Benzene increased in 2003 at both the urban sites. The trend for benzene at Forest Hills was down from 1992 to 1999. Since then, levels have remained similar or risen slightly. Benzene concentrations are consistently about 40% higher at Champlain Heights than at Forest Hills.

Butadiene is emitted during petroleum refining and subsequent handling, as well as from internal combustion engines (e.g. CARB, 1992). Butadiene, like benzene, rose at both sites in 2003 compared to the previous year. Butadiene concentrations appear similar at both urban sites. The long-term trend for butadiene essentially follows that for benzene.

Xylenes are associated with vehicle exhaust (Multistakeholder NOx/VOC Science Program, 1997a). Xylene concentrations rose at both sites in 2003. Considering the long-term trend, xylene concentrations do not appear to have changed as much since 1993 as some of the other key VOCs.

The oil refinery began a leak test and repair program in 1995, designed to reduce VOC emissions from leaking equipment such as pumps and valves. This may have been a factor in the observed decreases of many VOCs, although the bulk of the decrease took place between 1992 and 1995. Other changes may have had some influence, such as an increasing proportion of vehicles on the road being equipped with emission control devices. The recent increases are probably linked to the overall expansion of the refinery, and may also be affected by changes in other VOC emission sources in the area (e.g. other industry in the Grandview industrial park, road traffic, construction traffic).

15. QUALITY ASSURANCE

The provincial air quality network quality assurance program consists of a number of components, with input and responsibility from both DELG and Environment Canada. Sites managed by DELG are operated according to procedures and methods endorsed by the National Air Pollution Surveillance (NAPS) program, headquartered in Ottawa.

The objective of quality assurance procedures is to provide accurate, representative, comparable, high data quality using consistent operational protocols and standards. The NAPS agency provides calibration, reference standards, and technical support to DELG. Performance audits are also carried out annually. Calibration gases are certified for accuracy and are either "primary reference standards" or are traceable to primary standards maintained by the National Institute of Standards and Technology (NIST) in Maryland.

Instrumentation technologies used in both the provincial and industry networks must satisfy the requirements of the United States Environmental Protection Agency (EPA) as equivalent or reference method for ambient air monitoring. Methods not yet certified by the EPA are used if approved and tested by the NAPS agency.

Quality assurance tasks in the operation of monitoring stations include regular site inspections, instrument response verifications and analyzer calibrations.

Air quality monitoring analysers are specialised instruments, requiring regular maintenance to ensure acceptable operation. In addition, calibration procedures are necessary to ensure accurate results are obtained. For instruments measuring pollutants in gas form, calibration involves introducing known concentrations of the pollutant gas to the analyser, and monitoring the response. Three or four concentration values are used when performing such a "multipoint" calibration. Certified flow, temperature and pressure standards are used for equipment which measures particulate matter.

Audits of sites operated by DELG are performed by Environment Canada on randomly selected sites within the provincial network. An interlaboratory testing program is also conducted annually. This consists of the analysis of gases supplied "blind" (i.e. with no information on the true concentration) by the NAPS laboratory. DELG technicians analyze the blind test gas using their calibration equipment and send the results to NAPS, who return a report on performance to the province. This serves to standardize the performance of calibration systems within the province and across the country.

Performance and system/operator audits are carried out by DELG every two years to ensure acceptable data quality. Industry network audits are performed yearly, using NAPS certified standards (see the following section).

After data have been acquired, they are all validated. This involves examining results, taking into account instrument records, especially "zero and span drift" (measures of internal instrument changes), other site records, maintenance procedures, calibration of the analyzers, adjustments made to operating settings, performance and history of the analyzers, seasonal conditions, and changes and levels of other pollutants during a given time frame.

AIR QUALITY SITE AUDITS - 2003					
Industry	**Site**	**Parameter**	**Date**	**Absolute difference from standard (%)**	**Pass/fail**
AV Cell	Boom Rd.	SO_2	9 July	4.5	P
(Bathurst)	Dairy Queen Site	SO_2	9 July	6.5	P
Fraser Inc/Nexor	Cormier School	SO_2	27Jun	4.8	P
(Edmundston)	Cormier School	$PM_{2.5}$	27Jun	1.5	P
	St Mary	SO_2	27Jun	6.0	P
Irving Pulp and Paper	Sherbrooke St	TRS	13 Jul	9.6	P
(Saint John)	Indian Town	TRS	12 Nov	4.2	P
Irving Oil Limited	Silver Falls	SO_2	17 Dec	19.0	F (1)
(Saint John)	Paper Mill Pond	SO_2	3 Apr	4.0	P
	Champlain Heights	$PM_{2.5}$	3 Apr	5.2	P
NB Power Millbank	Lower Newcastle	NO_2	5 Feb	3.3	P
(Miramichi)	Lower Newcastle	SO_2	5 Feb	1.3	P
	Rockcliff	NO_2	7 Feb	2.6	P
	Rockcliff	SO_2	7 Feb	1.8	P
NB Power Dalhousie	Pointe La Nim	SO_2	20 Nov	2.0	P
(Dalhousie)	Pointe à la Garde	SO_2	23 Sep	4.0	P
	Mobile/ Pt. La Nim	SO_2	20 Nov	10.0	P
	Bayview	SO_2	20 Nov	23.0	F (2)
	Charlo	SO_2	23 Sep	2.0	P
NB Power Belledune	Municipal Hall	NO_2	19 Mar	2.0	P
(Belledune)	Municipal Hall	SO_2	19 Mar	6.0	P
	Belledune East	NO_2	20 Mar	6.2	P
	Belledune East	SO_2	20 Mar	9.3	P
	Jacquet River	SO_2	22 Sep	3.0	P
	Madran	SO_2	22 Sep	5.0	P
	Pointe Verte	SO_2	20 Sep	5.6	P
NB Power Grand Lake	Bailey Point	SO_2	2 Apr	1.8	P
UPM-Kymmene	King George Hwy	TRS	26 Jun	14.0	P
(Miramichi)	Groundwood Mill	TRS	26 Jun	16.0	F (3)
	King George Hwy	TRS	5 Dec	6.7	P
	Groundwood Mill	TRS	5 Dec	1.5	P
Brunswick Mining and Smelting	Chalmers	SO_2	25 Nov	39.5	F (4)
(Belledune)	Boulay	SO_2	25 Nov	13.0	P
	Town Site	SO_2	24 Nov	51.0	F (5)
Weyerhaeuser	Hay Lane	$PM_{2.5}$	5 Dec	10.0	P
(Miramichi)	Fire Ponds	$PM_{2.5}$	5 Dec	1.8	P

Notes: Details of corrective action taken when analyzers failed an audit: (1) Service and recalibration Dec 22, 2003. (2) Service and recalibration Nov 25, 2003. (3) Service and recalibration Aug 13, 2003. (4) and (5) Service and recalibration Nov 28, 2003. Instruments testing +/-15% are considered to be providing invalid data and require service/recalibration. Instruments testing +/-10% are identified for service and recalibration, with data considered acceptable.

Audits of Industry-operated sites

To ensure data quality, NBDELG technicians visit the monitoring sites operated by industries in New Brunswick, and perform independent site audits. It is normal to check all operating analysers at least once per year, or more often if required. Audits help identify and solve problems, prevent problems from developing, and assure data quality within the provincial monitoring system.

Results of air quality monitoring audits in 2003 are summarised in the preceding table. A total of 36 instrument audits were carried out in 2003.

APPENDIX I: CANADIAN NATIONAL AIR QUALITY OBJECTIVES

		Sulphur Dioxide	TSP	Carbon Monoxide	Ozone	Nitrogen Dioxide	Hydrogen Sulphide (Proposed)
		ppb	$\mu g/m^3$	ppm	ppb	ppb	ppb
Maximum Tolerable Level[1]	1 h				153	532	
	8 h			17.5			
	24 h	306	400			160	
	1 yr.						
Maximum Acceptable Level[2]	1 h	344		30.6	82	213	10.8
	8 h			13.1			
	24 h	115	120		25	106	3.6
	1 yr.	23	70		15	53	
Maximum Desirable Level[3]	1 h	172		13.1	51		0.7
	8 h			5.2			
	24 h	57			15		
	1 yr.	11	60			0.03	

Notes: 1. The maximum tolerable level denotes a concentration of an air pollutant that requires abatement without delay to avoid further deterioration to air quality that poses a substantial risk to public health.

2. The acceptable level is intended to provide adequate protection against adverse effects on soil, water, vegetation, materials, animals, visibility, personal comfort and well being.

3. The desirable level defines the long-term goal for air quality and provides the basis for an anti-degradation policy for the unpolluted parts of the country.

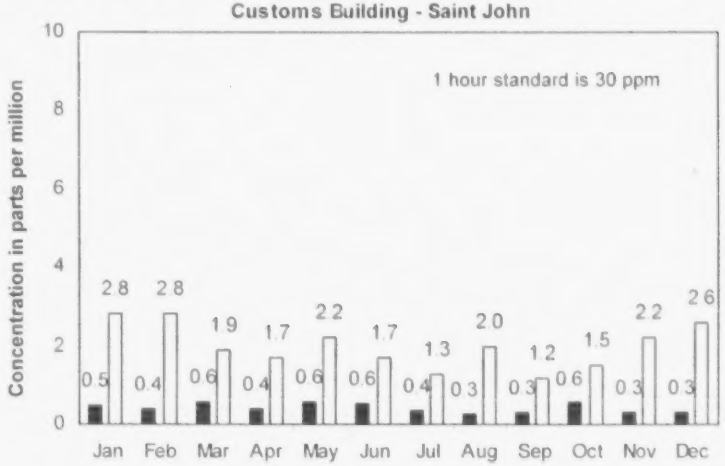
TSP : Total suspended particulate.

$\mu g/m^3$: Micrograms per cubic metre.

APPENDIX II:
DETAILED MONTHLY MONITORING RESULTS FOR 2003

Monthly average and maximum 1 hour values of Carbon Monoxide in 2003

Customs Building - Saint John


1 hour standard is 30 ppm
Concentration in parts per million
0 2 4 6 8 10
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
0.5 2.8 0.4 2.8 0.6 1.9 0.4 1.7 0.6 2.2 0.6 1.7 0.4 1.3 0.3 2.0 0.3 1.2 0.6 1.5 0.3 2.2 0.3 2.6

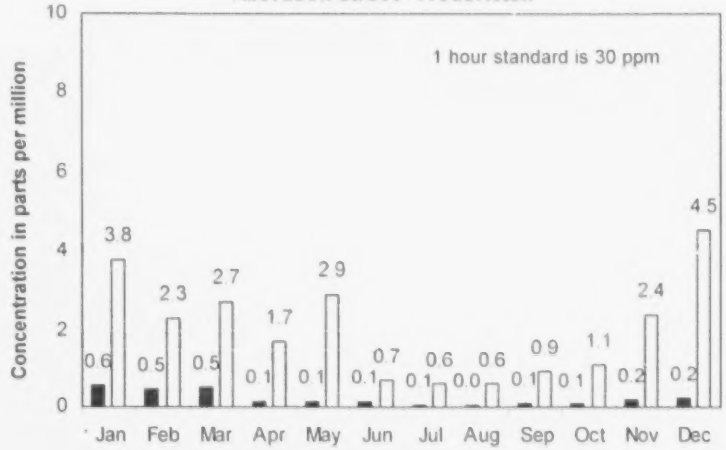
Monthly average and maximum 1 hour values of Carbon Monoxide in 2003

Highfield Street - Moncton

1 hour standard is 30 ppm
Concentration in parts per million
0 2 4 6 8 10
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
0.7 3.0 0.6 2.0 0.7 1.7 0.5 1.2 0.4 0.8 0.4 0.9 0.4 0.9 0.3 0.9 0.3 0.9 0.3 1.1 0.5 2.2 0.7 2.7

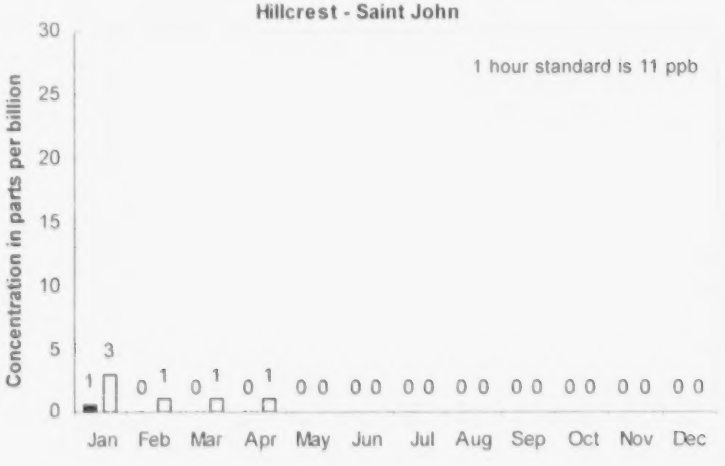
Monthly average and maximum 1 hour values of Carbon Monoxide in 2003

Aberdeen Street - Fredericton


1 hour standard is 30 ppm
Concentration in parts per million
0 2 4 6 8 10
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
0.6 3.8 0.5 2.3 0.5 2.7 0.1 1.7 0.1 2.9 0.1 0.7 0.1 0.6 0.0 0.6 0.1 0.9 0.1 1.1 0.2 2.4 0.2 4.5

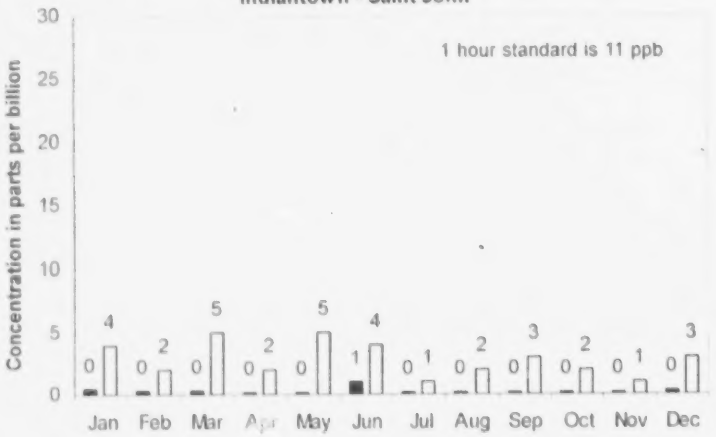
Monthly Average and Maximum One Hour Values of Total Reduced Sulphur in 2003

Hillcrest - Saint John


1 hour standard is 11 ppb
Concentration in parts per billion
0 5 10 15 20 25 30
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
1 3 0 1 0 1 0 1 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0

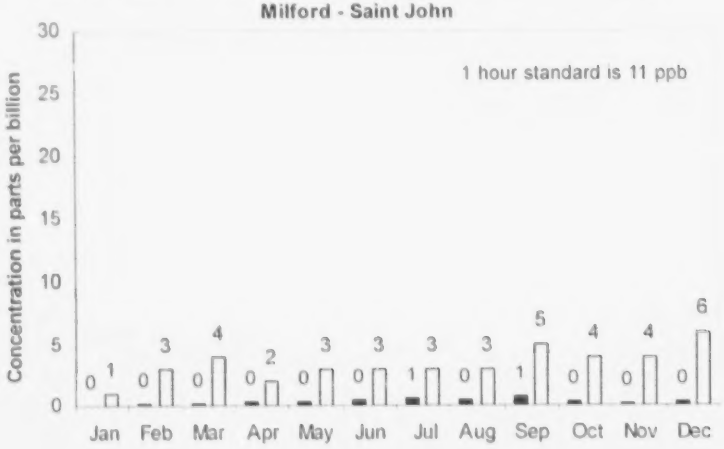
Monthly Average and Maximum One Hour Values of Total Reduced Sulphur in 2003

Indiantown - Saint John



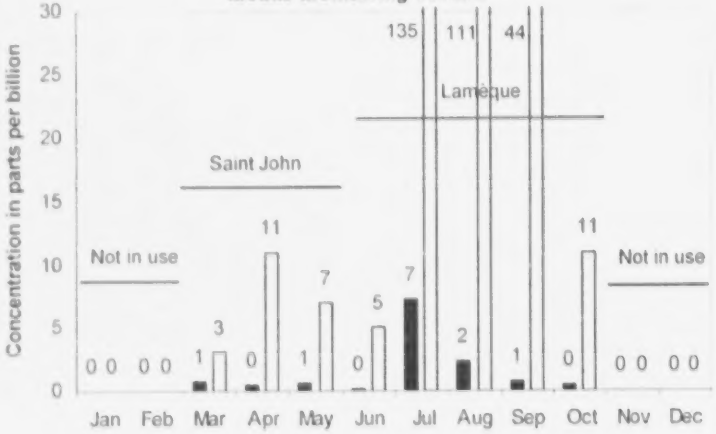
Monthly Average and Maximum One Hour Values of Total Reduced Sulphur in 2003

Milford - Saint John



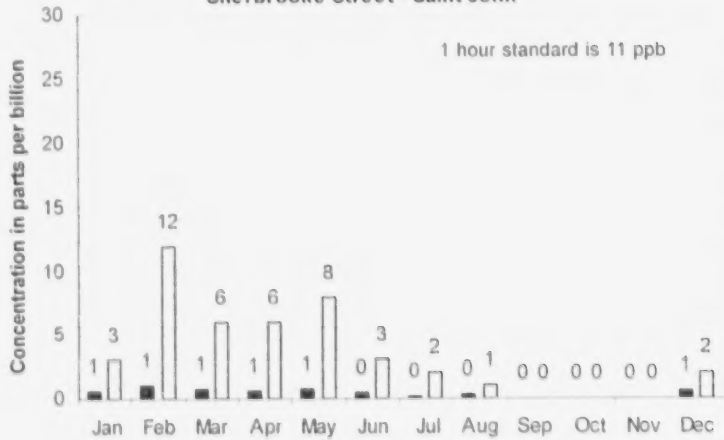
Monthly Average and Maximum One Hour Values of Total Reduced Sulphur in 2003

Mobile Monitoring Vehicle



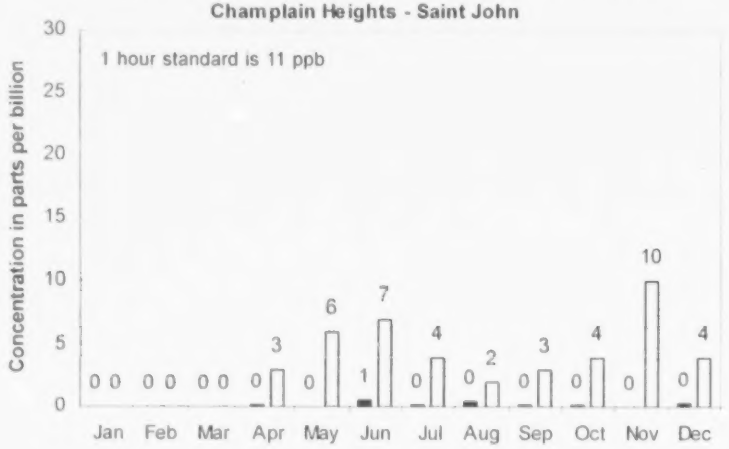
Monthly Average and Maximum One Hour Values of Total Reduced Sulphur in 2003

Sherbrooke Street - Saint John



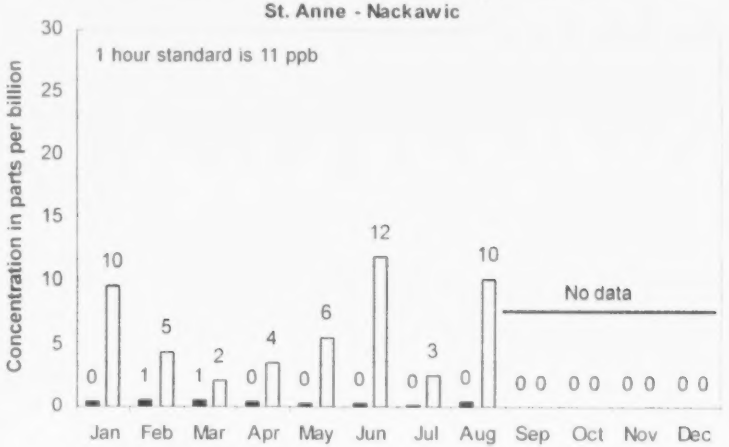
Monthly Average and Maximum One Hour Values of Total Reduced Sulphur in 2003

Champlain Heights - Saint John


1 hour standard is 11 ppb
Concentration in parts per billion
0 5 10 15 20 25 30
0 0 0 0 0 0 0 3 0 6 1 7 0 4 0 2 0 3 0 4 0 10 0 4
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

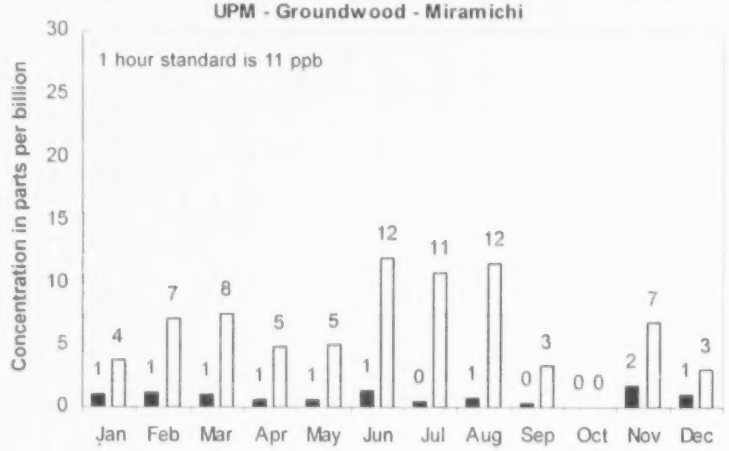
Monthly Average and Maximum One Hour Values of Total Reduced Sulphur in 2003

St. Anne - Nackawic


1 hour standard is 11 ppb
Concentration in parts per billion
0 5 10 15 20 25 30
0 10 1 5 1 2 0 4 0 6 0 12 0 3 0 10 No data 0 0 0 0 0 0 0 0
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

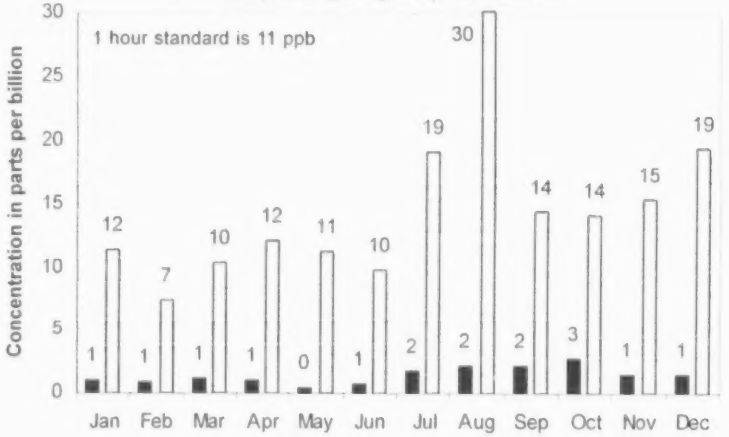
Monthly Average and Maximum One Hour Values of Total Reduced Sulphur in 2003

UPM - Groundwood - Miramichi


1 hour standard is 11 ppb
Concentration in parts per billion
0 5 10 15 20 25 30
1 4 1 7 1 8 1 5 1 5 1 12 0 11 1 12 0 3 0 0 2 7 1 3
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

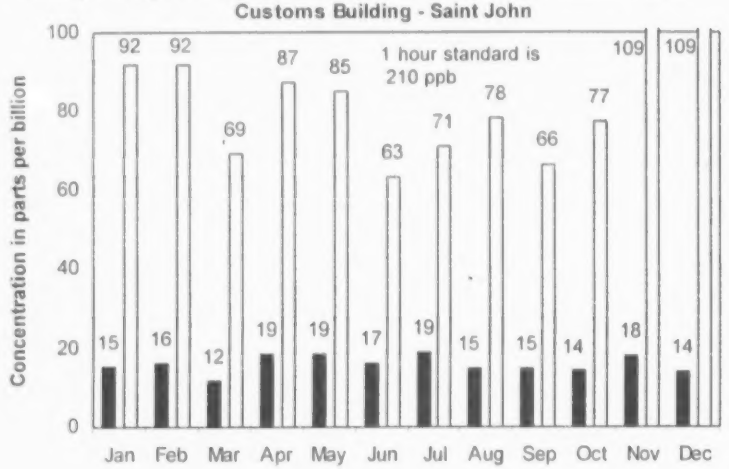
Monthly Average and Maximum One Hour Values of Total Reduced Sulphur in 2003

UPM - King George Highway - Miramichi


1 hour standard is 11 ppb
Concentration in parts per billion
0 5 10 15 20 25 30
1 12 1 7 1 10 1 12 0 11 1 10 2 19 2 30 2 14 3 14 1 15 1 19
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

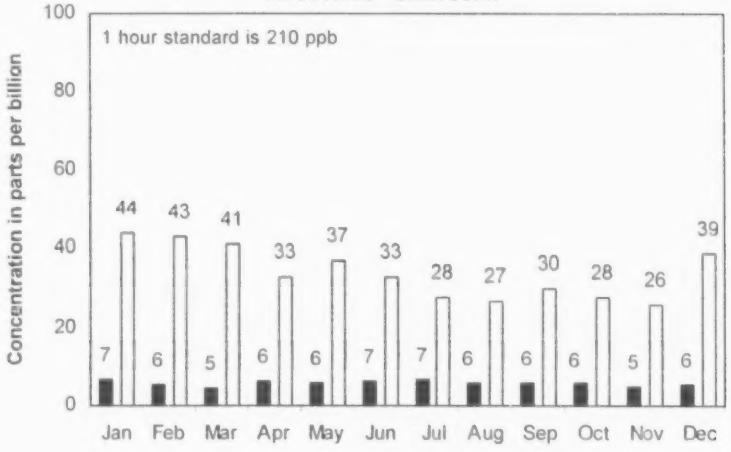
Monthly Average and Maximum One Hour Values of Nitrogen Dioxide in 2003

Customs Building - Saint John



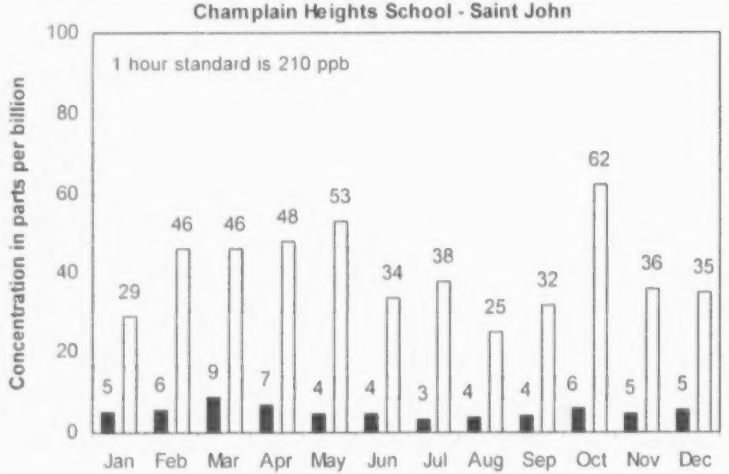
Monthly Average and Maximum One Hour Values of Nitrogen Dioxide in 2003

Forest Hills - Saint John



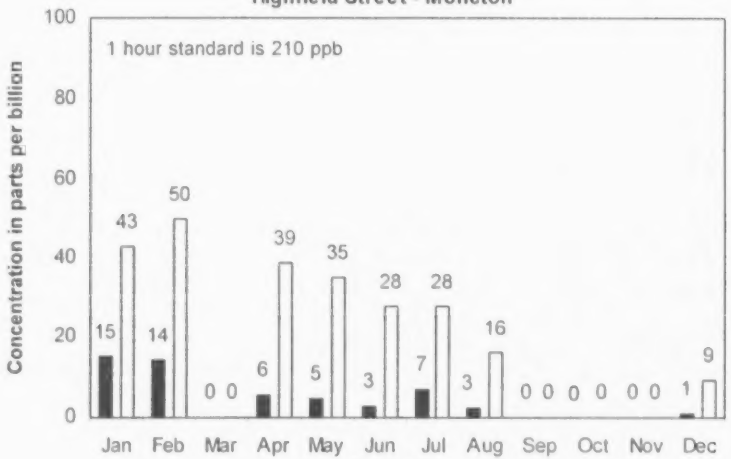
Monthly Average and Maximum One Hour Values of Nitrogen Dioxide in 2003

Champlain Heights School - Saint John



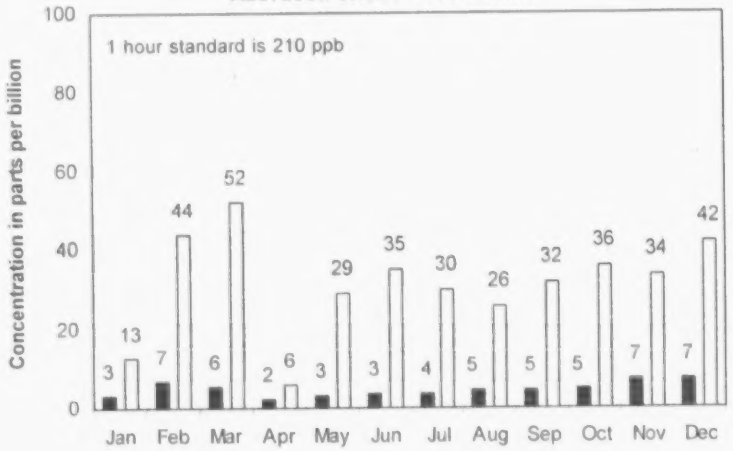
Monthly Average and Maximum One Hour Values of Nitrogen Dioxide in 2003

Highfield Street - Moncton



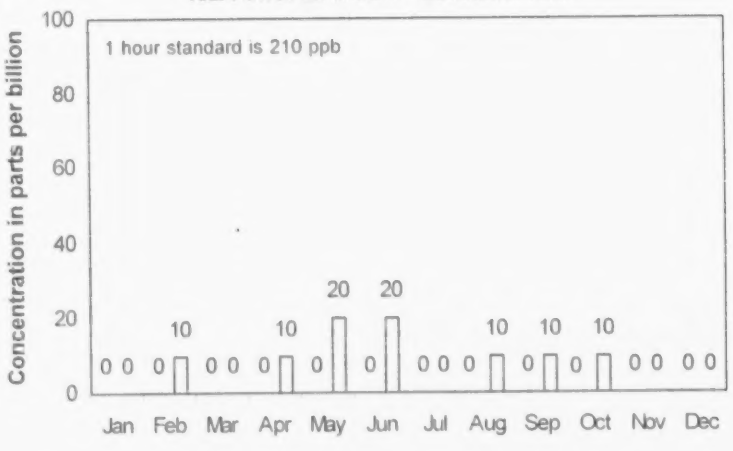
Monthly Average and Maximum One Hour Values of Nitrogen Dioxide in 2003

Aberdeen Street - Fredericton


1 hour standard is 210 ppb
Concentration in parts per billion
100
80
60
40
20
0
3 13 7 44 6 52 2 6 3 29 3 35 4 30 5 26 5 32 5 36 7 34 7 42
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

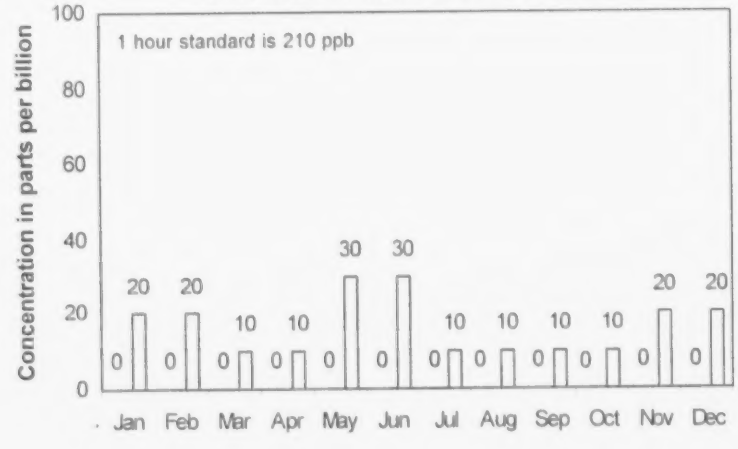
Monthly Average and Maximum One Hour Values of Nitrogen Dioxide in 2003

N.B. Power Belledune - Belledune East


1 hour standard is 210 ppb
Concentration in parts per billion
100
80
60
40
20
0
0 0 0 10 0 0 0 10 0 20 0 20 0 0 0 10 0 10 0 10 0 0 0 0
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

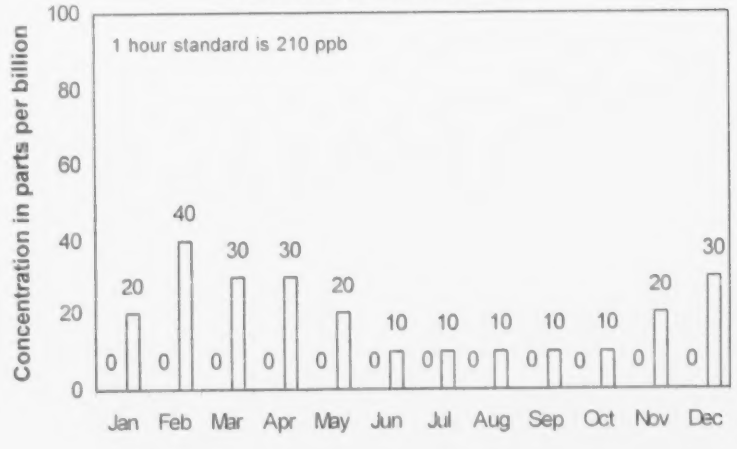
Monthly Average and Maximum One Hour Values of Nitrogen Dioxide in 2003

N.B. Power Belledune - Municipal Hall


1 hour standard is 210 ppb
Concentration in parts per billion
100
80
60
40
20
0
0 20 0 20 0 10 0 10 0 30 0 30 0 10 0 10 0 10 0 10 0 20 0 20
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

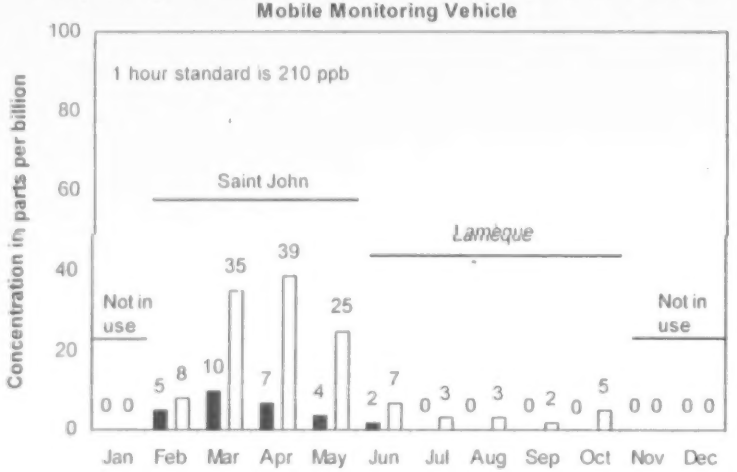
Monthly Average and Maximum One Hour Values of Nitrogen Dioxide in 2003

N.B. Power Millbank - Rockcliff


1 hour standard is 210 ppb
Concentration in parts per billion
100
80
60
40
20
0
0 20 0 40 0 30 0 30 0 20 0 10 0 10 0 10 0 10 0 10 0 20 0 30
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

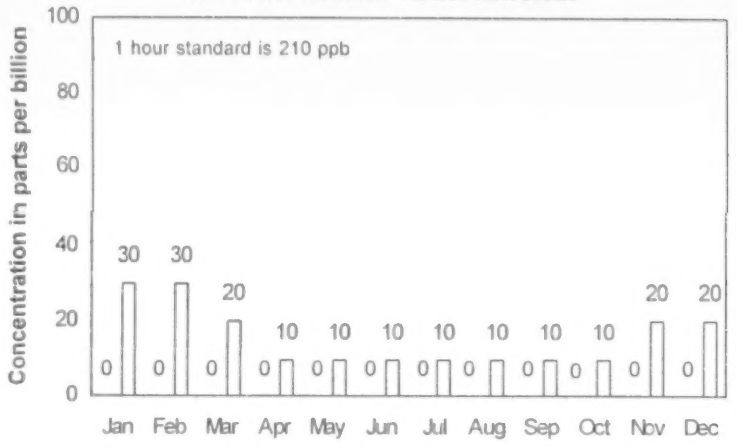
Monthly Average and Maximum One Hour Values of Nitrogen Dioxide in 2003

Mobile Monitoring Vehicle



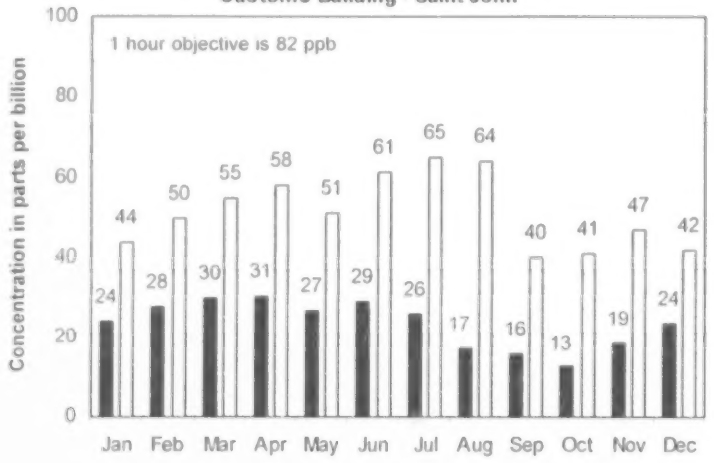
Monthly Average and Maximum One Hour Values of Nitrogen Dioxide in 2003

N.B. Power Millbank - Lower Newcastle



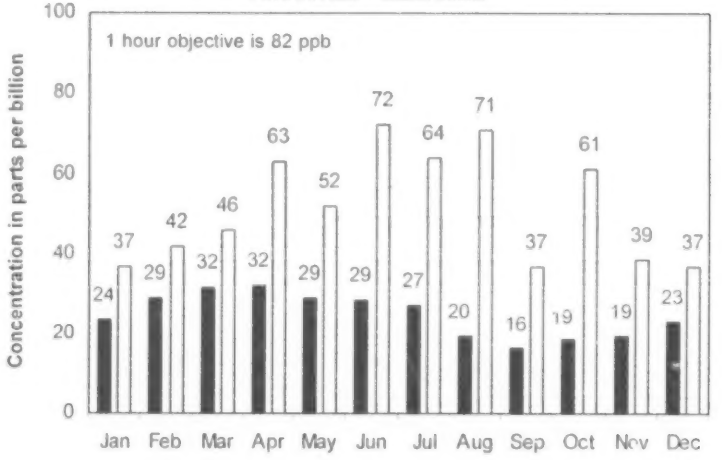
Monthly Average and Maximum One Hour Values of Ozone in 2003

Customs Building - Saint John



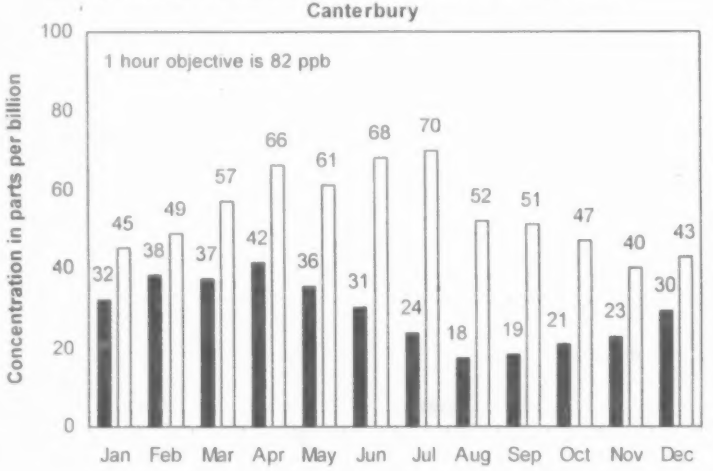
Monthly Average and Maximum One Hour Values of Ozone in 2003

Forest Hills - Saint John



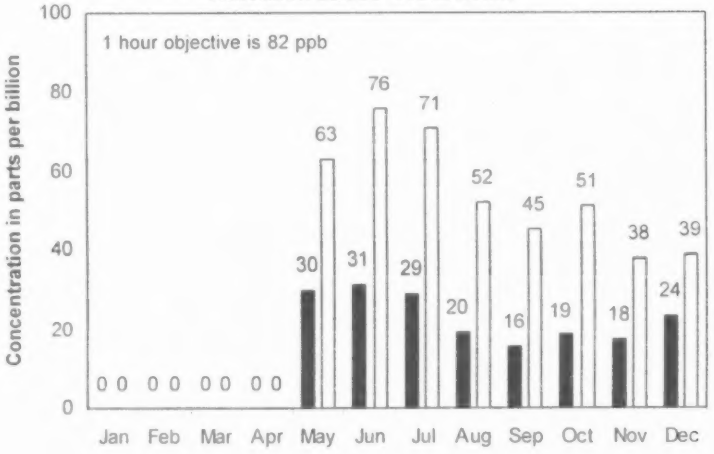
Monthly Average and Maximum One Hour Values of Ozone in 2003

Canterbury


1 hour objective is 82 ppb
Concentration in parts per billion
100
80
60
40
20
0
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
32 45 38 49 37 57 42 66 36 61 31 68 24 70 18 52 19 51 21 47 23 40 30 43

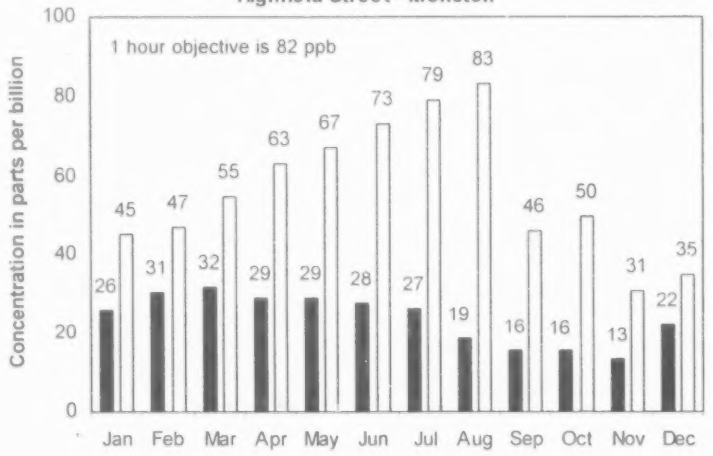
Monthly Average and Maximum One Hour Values of Ozone in 2003

Aberdeen Street - Fredericton


1 hour objective is 82 ppb
Concentration in parts per billion
100
80
60
40
20
0
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
0 0 0 0 0 0 0 0 30 63 31 76 29 71 20 52 16 45 19 51 18 38 24 39

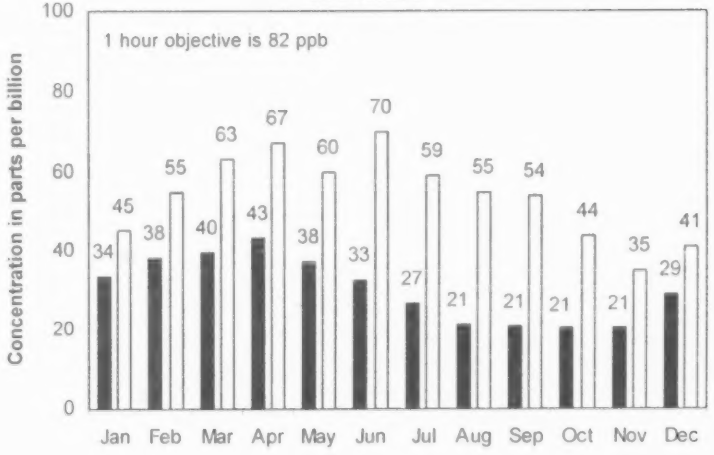
Monthly Average and Maximum One Hour Values of Ozone in 2003

Highfield Street - Moncton


1 hour objective is 82 ppb
Concentration in parts per billion
100
80
60
40
20
0
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
26 45 31 47 32 55 29 63 29 67 28 73 27 79 19 83 16 46 16 50 13 31 22 35

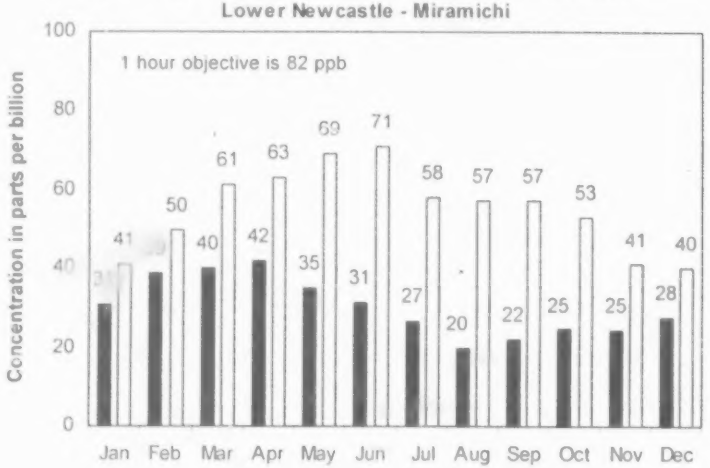
Monthly Average and Maximum One Hour Values of Ozone in 2003

St. Leonard


1 hour objective is 82 ppb
Concentration in parts per billion
100
80
60
40
20
0
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
34 45 38 55 40 63 43 67 38 60 33 70 27 59 21 55 21 54 21 44 21 35 29 41

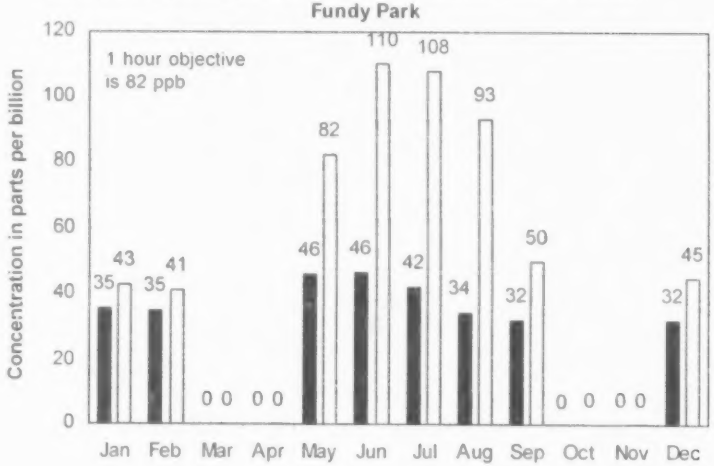
Monthly Average and Maximum One Hour Values of Ozone in 2003

Lower Newcastle - Miramichi


1 hour objective is 82 ppb
Concentration in parts per billion
100
80
60
40
20
0
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
41 50 40 61 42 63 35 69 31 71 27 58 20 57 22 57 25 53 25 41 28 40

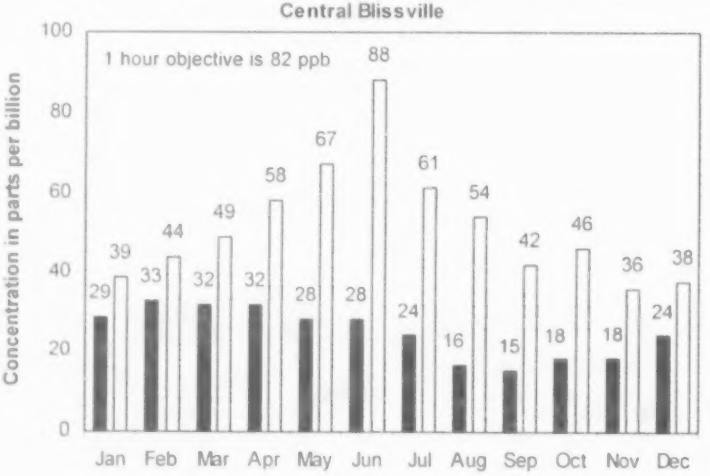
Monthly Average and Maximum One Hour Values of Ozone in 2003

Fundy Park


1 hour objective is 82 ppb
Concentration in parts per billion
120
100
80
60
40
20
0
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
35 43 35 41 0 0 0 0 46 82 46 110 42 108 34 93 32 50 0 0 0 0 32 45

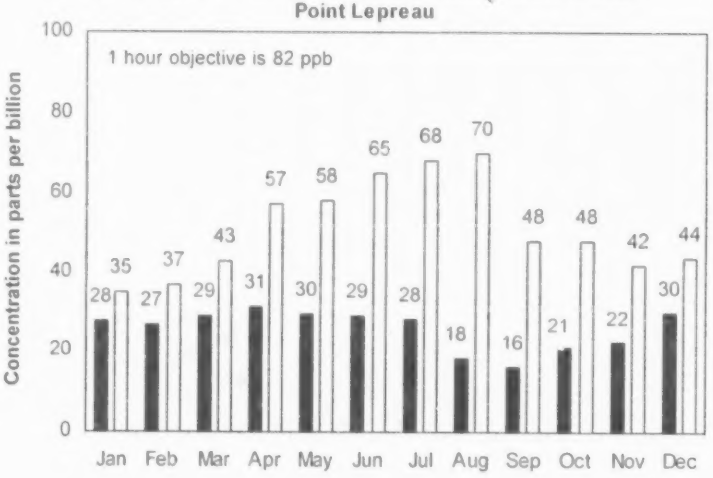
Monthly Average and Maximum One Hour Values of Ozone in 2003

Central Blissville


1 hour objective is 82 ppb
Concentration in parts per billion
100
80
60
40
20
0
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
29 39 33 44 32 49 32 58 28 67 28 88 24 61 16 54 15 42 18 46 18 36 24 38

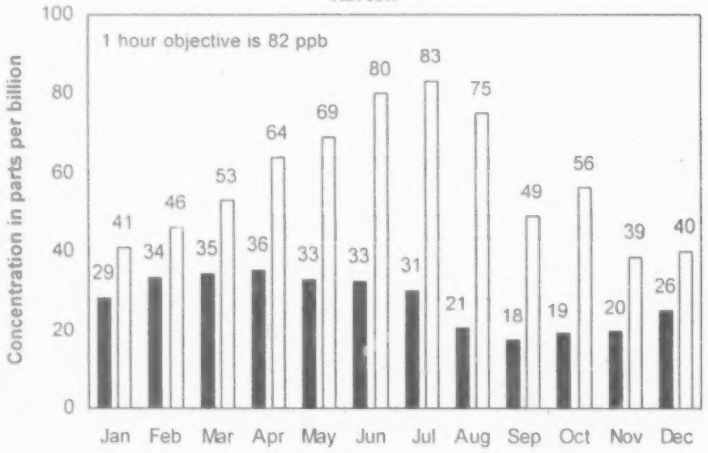
Monthly Average and Maximum One Hour Values of Ozone in 2003

Point Lepreau


1 hour objective is 82 ppb
Concentration in parts per billion
100
80
60
40
20
0
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
28 35 27 37 29 43 31 57 30 58 29 65 28 68 18 70 16 48 21 48 22 42 30 44

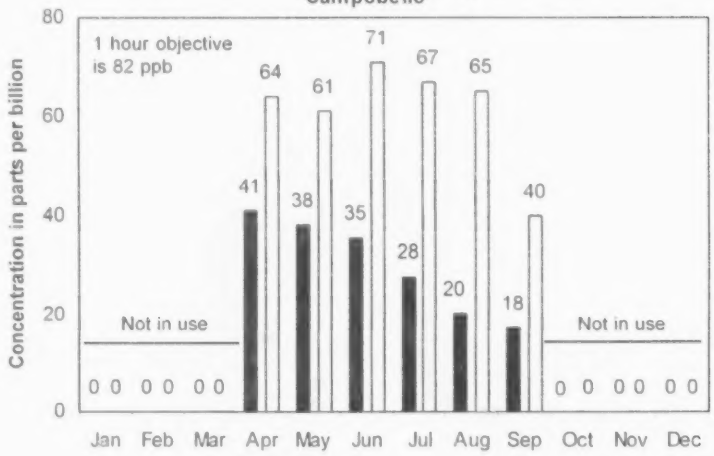
Monthly Average and Maximum One Hour Values of Ozone in 2003

Norton



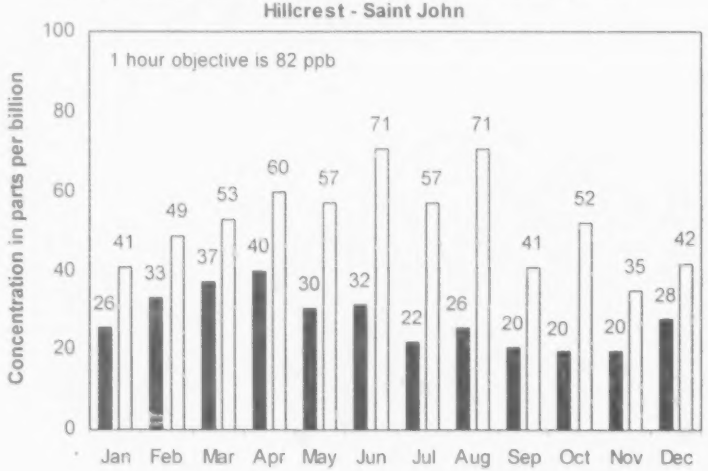
Monthly Average and Maximum One Hour Values of Ozone in 2003

Campobello



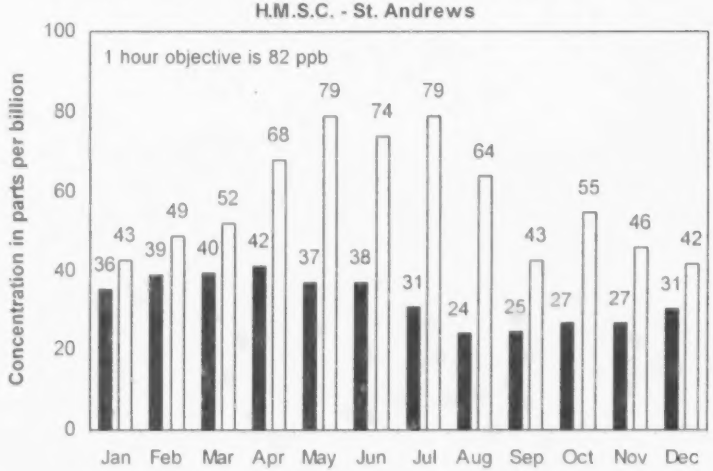
Monthly Average and Maximum One Hour Values of Ozone in 2003

Hillcrest - Saint John



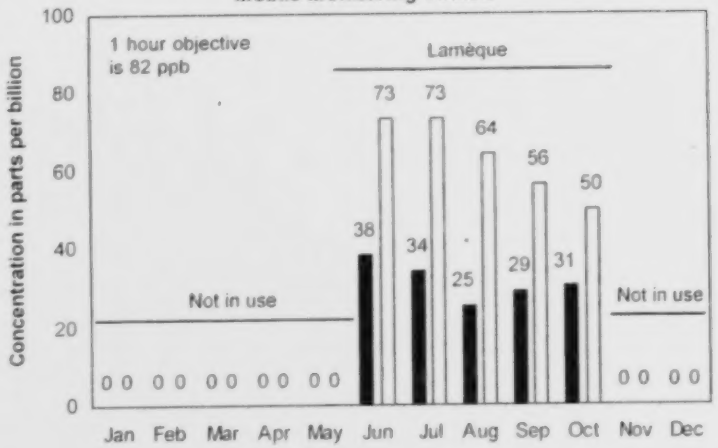
Monthly Average and Maximum One Hour Values of Ozone in 2003

H.M.S.C. - St. Andrews



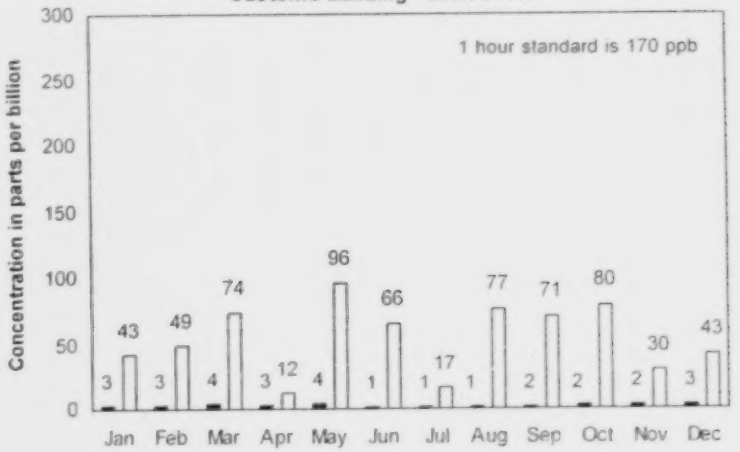
Monthly Average and Maximum One Hour Values of Ozone in 2003

Mobile Monitoring Vehicle


Concentration in parts per billion
100
80
60
40
20
0
1 hour objective is 82 ppb
Not in use
Lamèque
Not in use
0 0 0 0 0 0 0 0 0 0
38 73 34 73 25 64 29 56 31 50
0 0 0 0
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

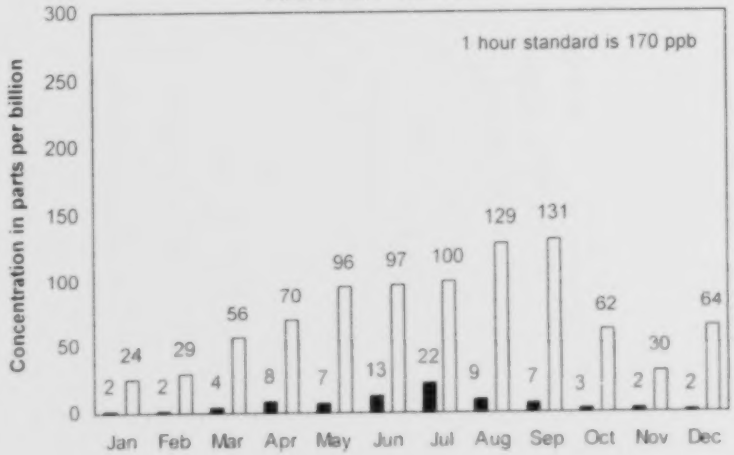
Monthly Average & Maximum One hour Values of Sulphur Dioxide in 2003

Customs Building - Saint John


Concentration in parts per billion
300
250
200
150
100
50
0
1 hour standard is 170 ppb
3 43 3 49 4 74 3 12 4 96 1 66 1 17 1 77 2 71 2 80 2 30 3 43
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

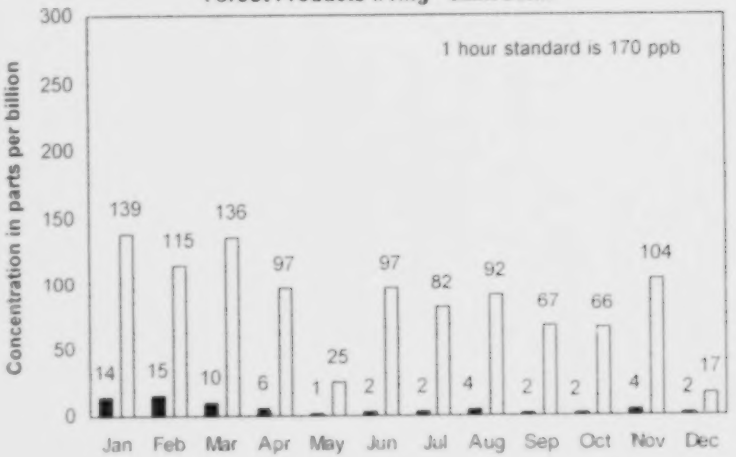
Monthly Average & Maximum One hour Values of Sulphur Dioxide in 2003

Forest Hills - Saint John


Concentration in parts per billion
300
250
200
150
100
50
0
1 hour standard is 170 ppb
2 24 2 29 4 56 8 70 7 96 13 97 22 100 9 129 7 131 3 62 2 30 2 64
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

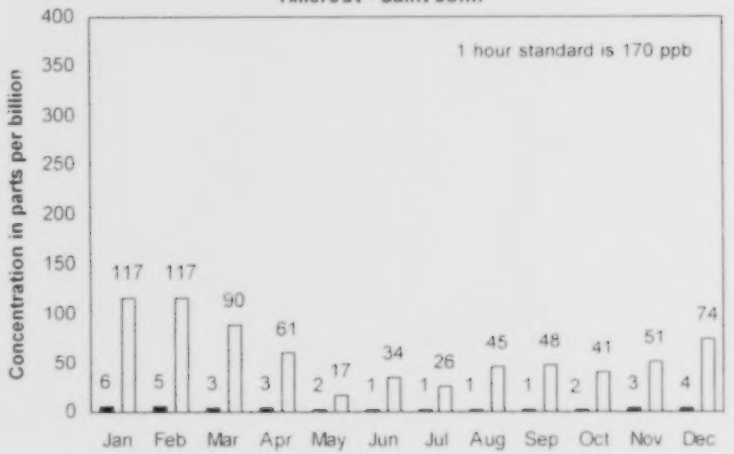
Monthly Average & Maximum One hour Values of Sulphur Dioxide in 2003

Forest Products Irving - Saint John


Concentration in parts per billion
300
250
200
150
100
50
0
1 hour standard is 170 ppb
14 139 15 115 10 136 6 97 1 25 2 97 2 82 4 92 2 67 2 66 4 104 2 17
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

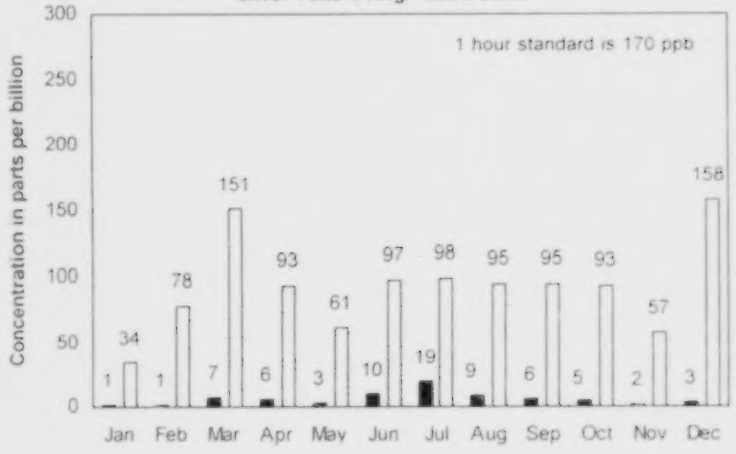
Monthly Average & Maximum One hour Values of Sulphur Dioxide in 2003

Hillcrest - Saint John



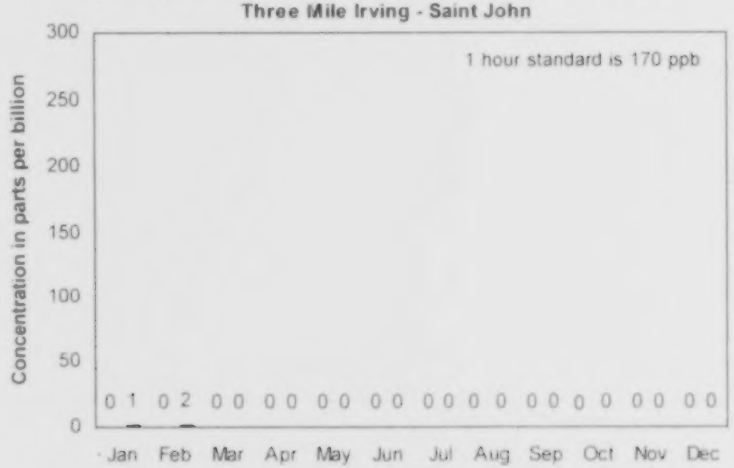
Monthly Average & Maximum One hour Values of Sulphur Dioxide in 2003

Silver Falls Irving - Saint John



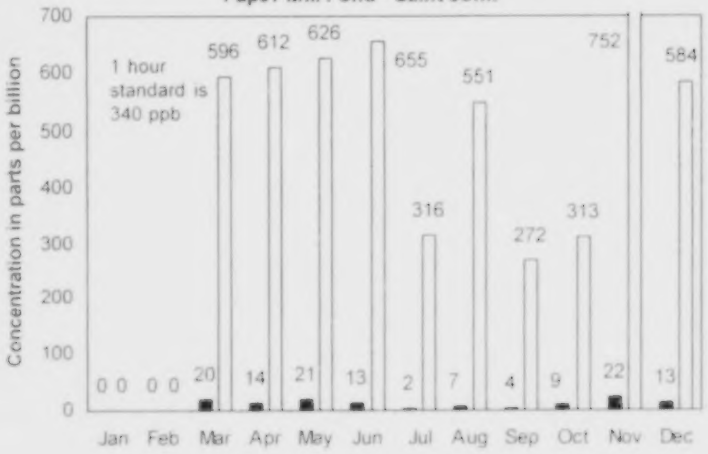
Monthly Average & Maximum One hour Values of Sulphur Dioxide in 2003

Three Mile Irving - Saint John



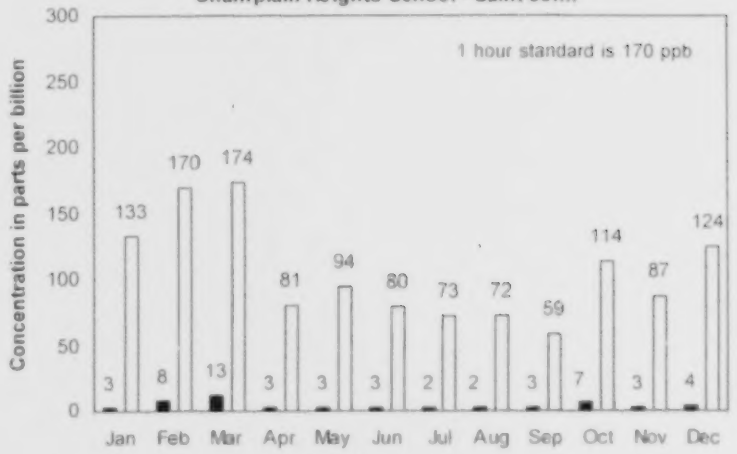
Monthly Average & Maximum One hour Values of Sulphur Dioxide in 2003

Paper Mill Pond - Saint John



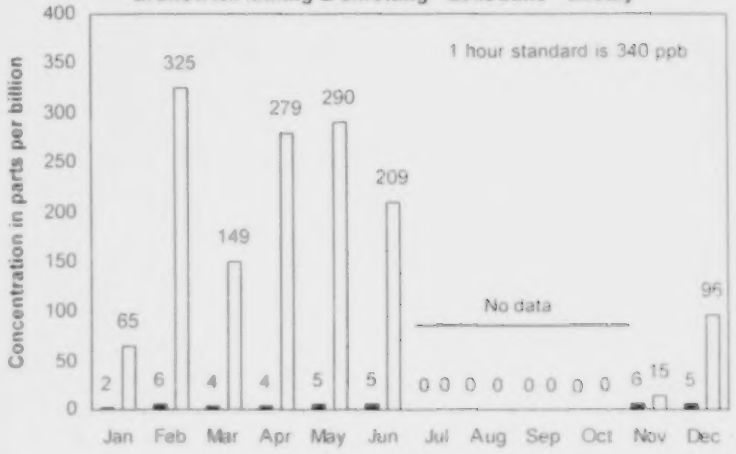
Monthly Average & Maximum One hour Values of Sulphur Dioxide in 2003

Champlain Heights School - Saint John



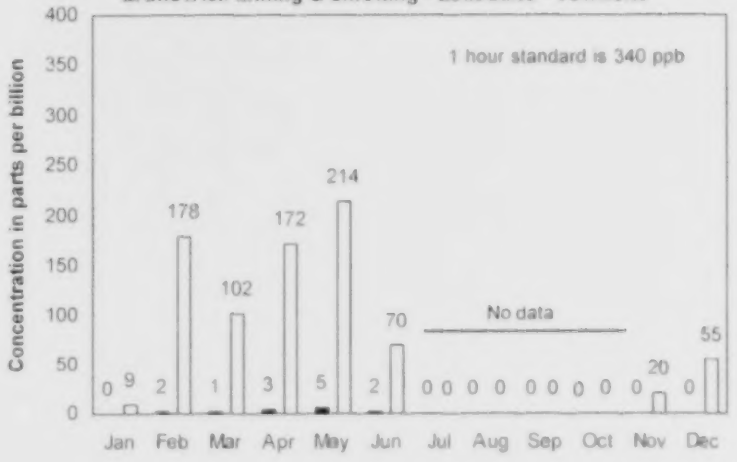
Monthly Average & Maximum One hour Values of Sulphur Dioxide in 2003

Brunswick Mining & Smelting - Belledune - Boulay



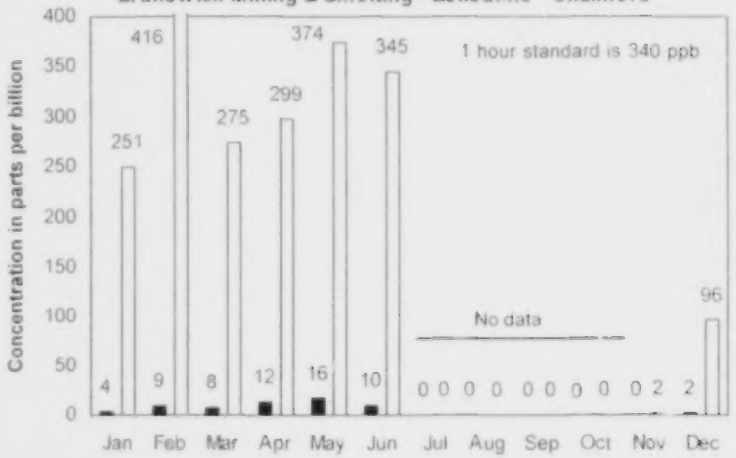
Monthly Average & Maximum One hour Values of Sulphur Dioxide in 2003

Brunswick Mining & Smelting - Belledune - Townsite



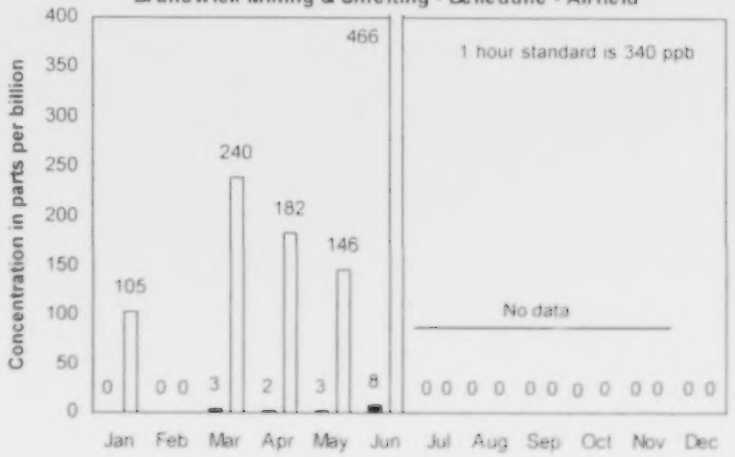
Monthly Average & Maximum One hour Values of Sulphur Dioxide in 2003

Brunswick Mining & Smelting - Belledune - Chalmers



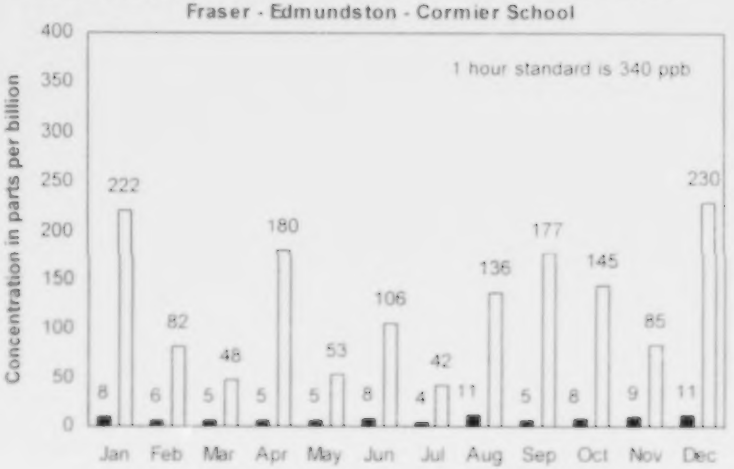
Monthly Average & Maximum One hour Values of Sulphur Dioxide in 2003

Brunswick Mining & Smelting - Belledune - Airfield



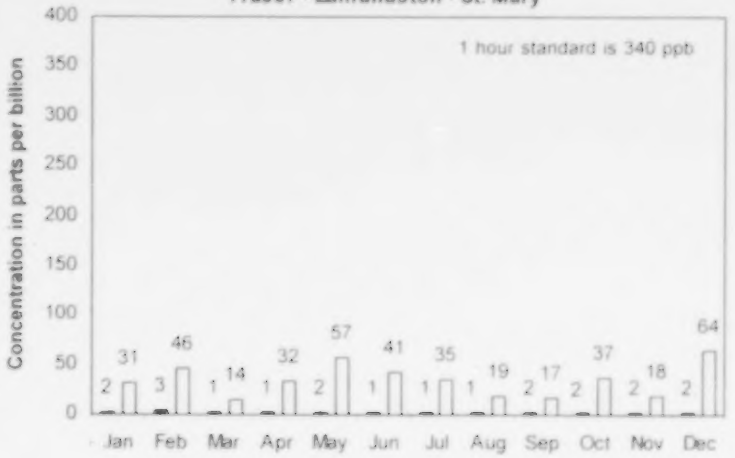
Monthly Average & Maximum One hour Values of Sulphur Dioxide in 2003

Fraser - Edmundston - Cormier School


Concentration in parts per billion
400
350
300
250
200
150
100
50
0
1 hour standard is 340 ppb
8 222 6 82 5 48 5 180 5 53 8 106 4 42 11 136 5 177 8 145 9 85 11 230
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

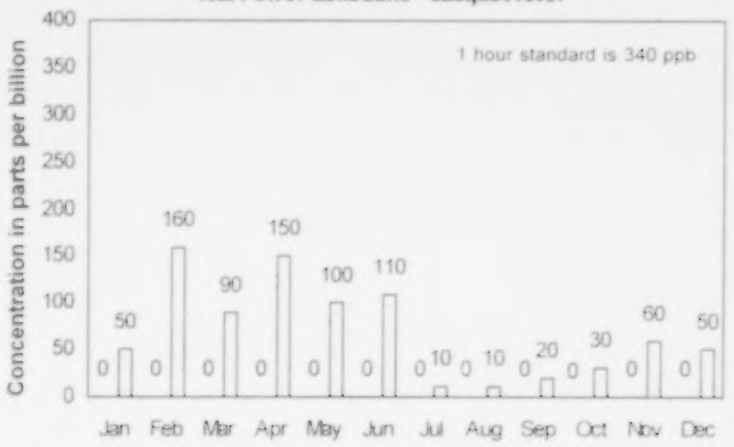
Monthly Average & Maximum One hour Values of Sulphur Dioxide in 2003

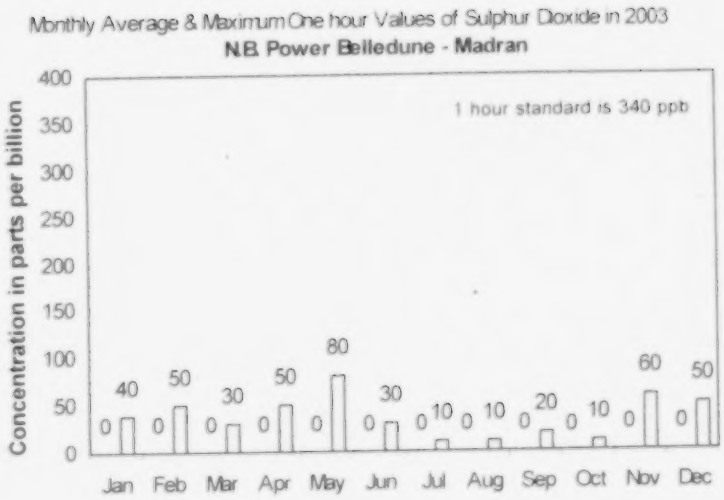
Fraser - Edmundston - St. Mary

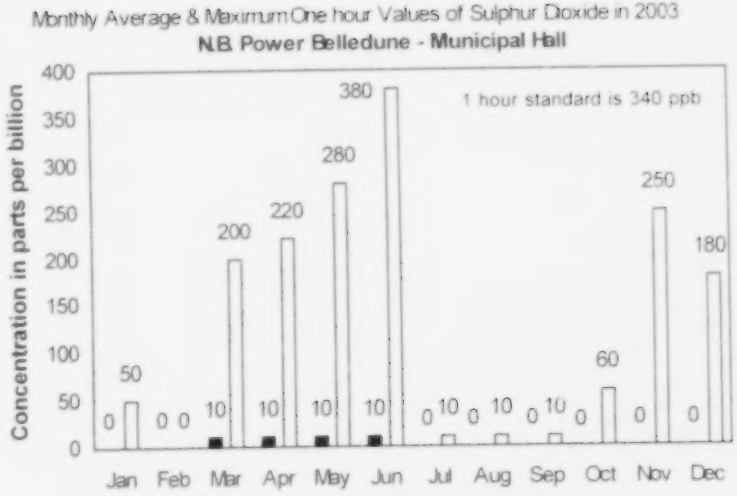

Concentration in parts per billion
400
350
300
250
200
150
100
50
0
1 hour standard is 340 ppb
2 31 3 46 1 14 1 32 2 57 1 41 1 35 1 19 2 17 2 37 2 18 2 64
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

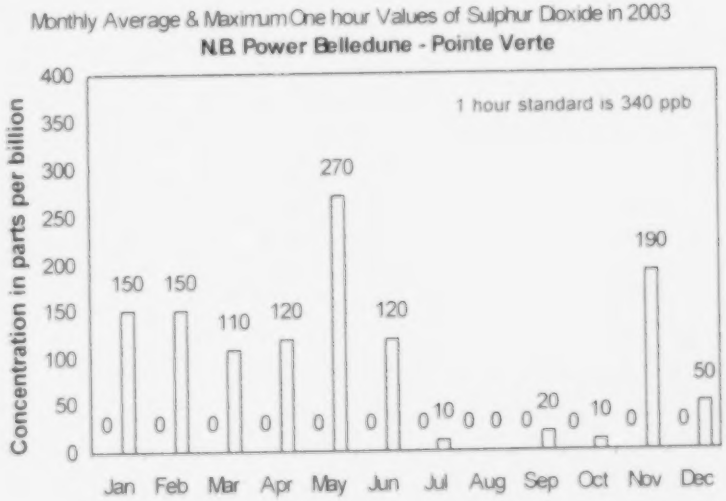
Monthly Average & Maximum One hour Values of Sulphur Dioxide in 2003

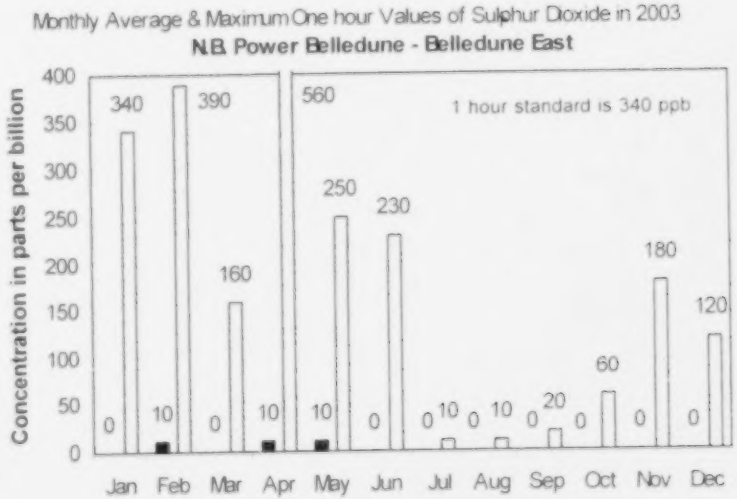
N.B. Power Belledune - Jacquet River


Concentration in parts per billion
400
350
300
250
200
150
100
50
0
1 hour standard is 340 ppb
0 50 0 160 0 90 0 150 0 100 0 110 0 10 0 10 0 20 0 30 0 60 0 50
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec


Monthly Average & Maximum One hour Values of Sulphur Dioxide in 2003
N.B. Power Belledune - Madran
Concentration in parts per billion
1 hour standard is 340 ppb
0 50 100 150 200 250 300 350 400
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
0 40 0 50 0 30 0 50 0 80 0 30 0 10 0 10 0 20 0 10 0 60 0 50

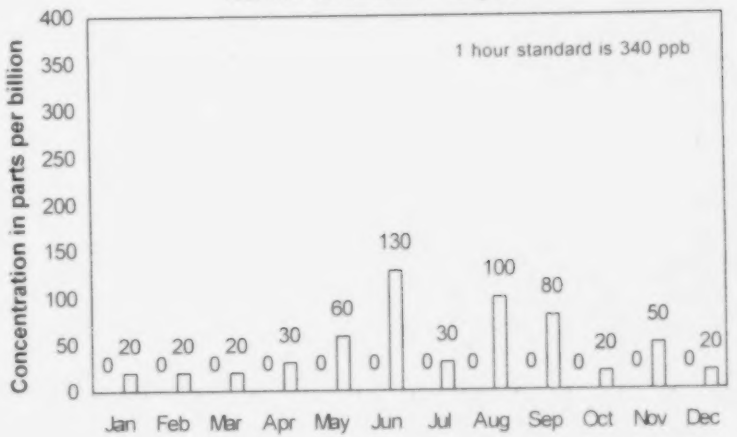

Monthly Average & Maximum One hour Values of Sulphur Dioxide in 2003
N.B. Power Belledune - Municipal Hall
Concentration in parts per billion
1 hour standard is 340 ppb
0 50 100 150 200 250 300 350 400
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
0 50 0 0 10 200 10 220 10 280 10 380 0 10 0 10 0 10 0 60 0 250 0 180


Monthly Average & Maximum One hour Values of Sulphur Dioxide in 2003
N.B. Power Belledune - Pointe Verte
Concentration in parts per billion
1 hour standard is 340 ppb
0 50 100 150 200 250 300 350 400
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
0 150 0 150 0 110 0 120 0 270 0 120 0 10 0 0 0 20 0 10 0 190 0 50


Monthly Average & Maximum One hour Values of Sulphur Dioxide in 2003
N.B. Power Belledune - Belledune East
Concentration in parts per billion
1 hour standard is 340 ppb
0 50 100 150 200 250 300 350 400
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
0 340 10 390 0 160 10 560 10 250 0 230 0 10 0 10 0 20 0 60 0 180 0 120

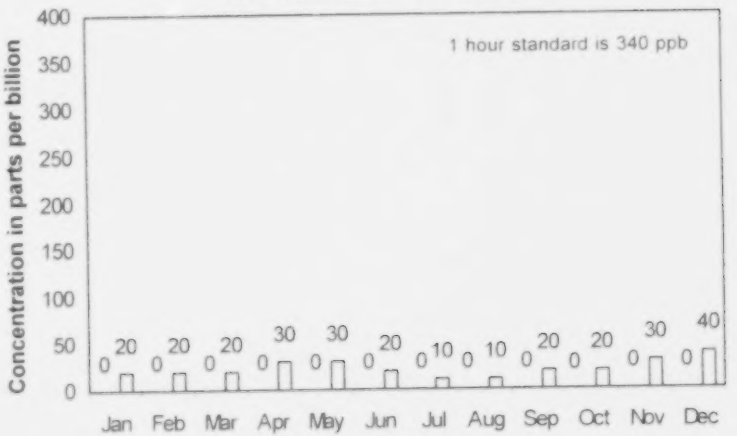
Monthly Average & Maximum One hour Values of Sulphur Dioxide in 2003

N.B. Power Dalhousie - Bayview


Concentration in parts per billion
1 hour standard is 340 ppb
400
350
300
250
200
150
100
50
0
0 20 0 20 0 20 0 30 0 60 0 130 0 30 0 100 0 80 0 20 0 50 0 20
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

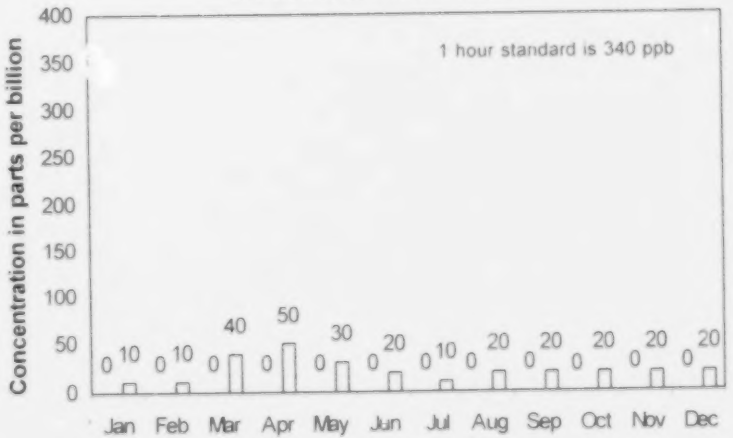
Monthly Average & Maximum One hour Values of Sulphur Dioxide in 2003

N.B. Power Dalhousie - Tower


Concentration in parts per billion
1 hour standard is 340 ppb
400
350
300
250
200
150
100
50
0
0 20 0 20 0 20 0 30 0 30 0 20 0 10 0 10 0 20 0 20 0 30 0 40
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

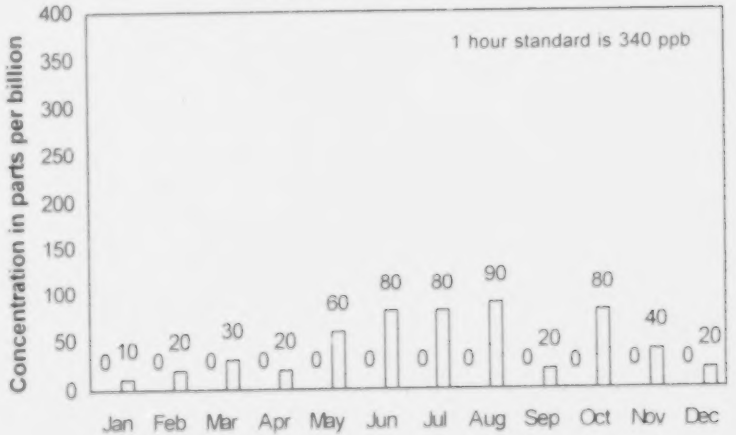
Monthly Average & Maximum One hour Values of Sulphur Dioxide in 2003

N.B. Power Dalhousie - Charlo


Concentration in parts per billion
1 hour standard is 340 ppb
400
350
300
250
200
150
100
50
0
0 10 0 10 0 40 0 50 0 30 0 20 0 10 0 20 0 20 0 20 0 20 0 20
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

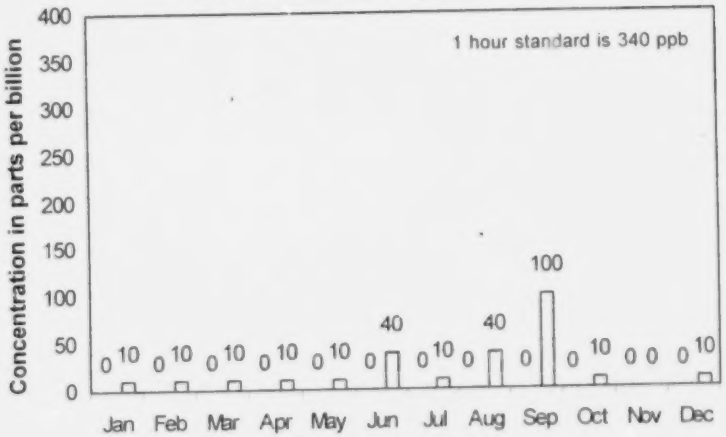
Monthly Average & Maximum One hour Values of Sulphur Dioxide in 2003

N.B. Power Dalhousie - Mobile


Concentration in parts per billion
1 hour standard is 340 ppb
400
350
300
250
200
150
100
50
0
0 10 0 20 0 30 0 20 0 60 0 80 0 80 0 90 0 20 0 80 0 40 0 20
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

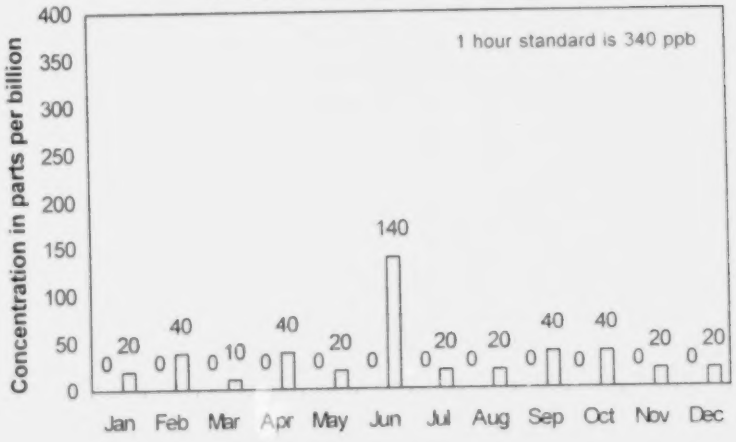
Monthly Average & Maximum One hour Values of Sulphur Dioxide in 2003

N.B. Power Dalhousie - Pointe à la Garde


Concentration in parts per billion
1 hour standard is 340 ppb
400
350
300
250
200
150
100
50
0
0 10 0 10 0 10 0 10 0 10 0 40 0 10 0 40 0 100 0 10 0 0 0 10
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

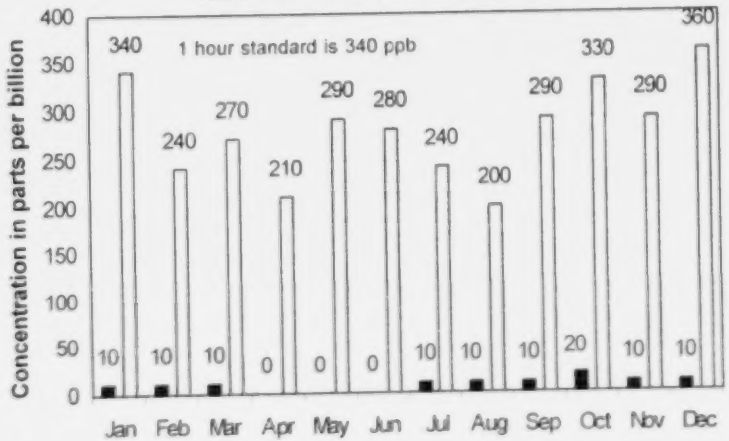
Monthly Average & Maximum One hour Values of Sulphur Dioxide in 2003

N.B. Power Dalhousie - Point la Nim


Concentration in parts per billion
1 hour standard is 340 ppb
400
350
300
250
200
150
100
50
0
0 20 0 40 0 10 0 40 0 20 0 140 0 20 0 20 0 40 0 40 0 20 0 20
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

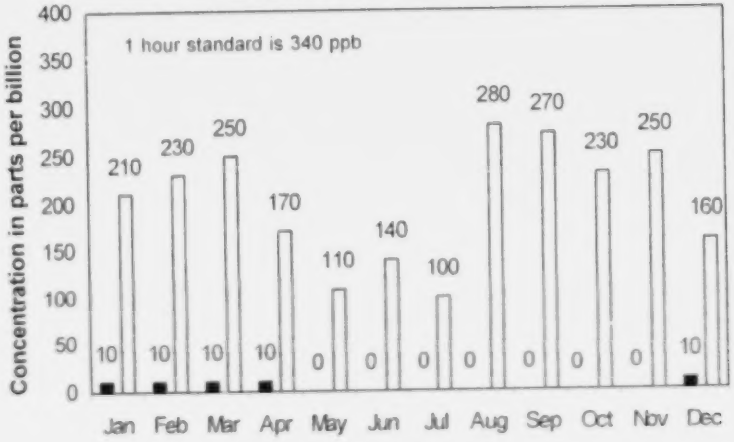
Monthly Average & Maximum One hour Values of Sulphur Dioxide in 2003

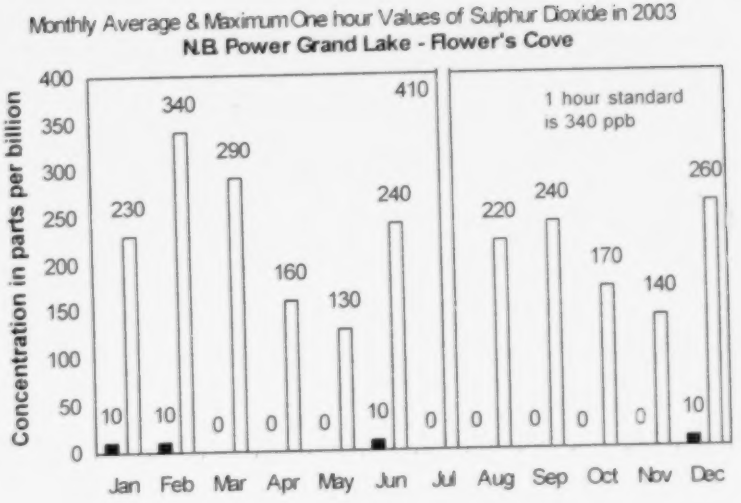
N.B. Power Grand Lake - Bailey Point

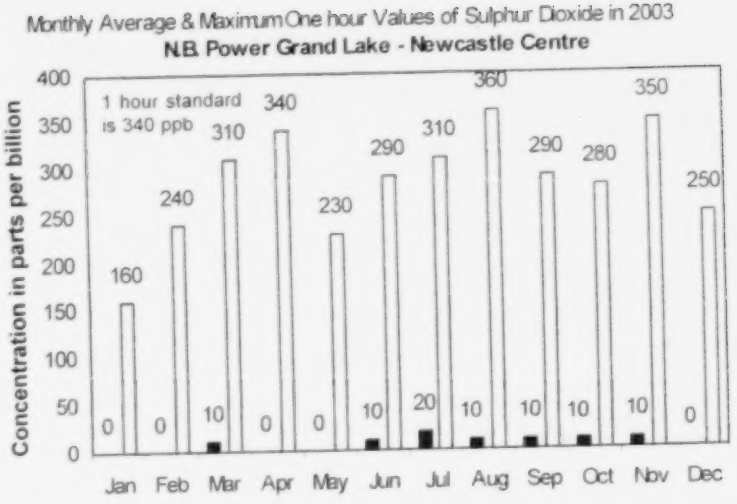


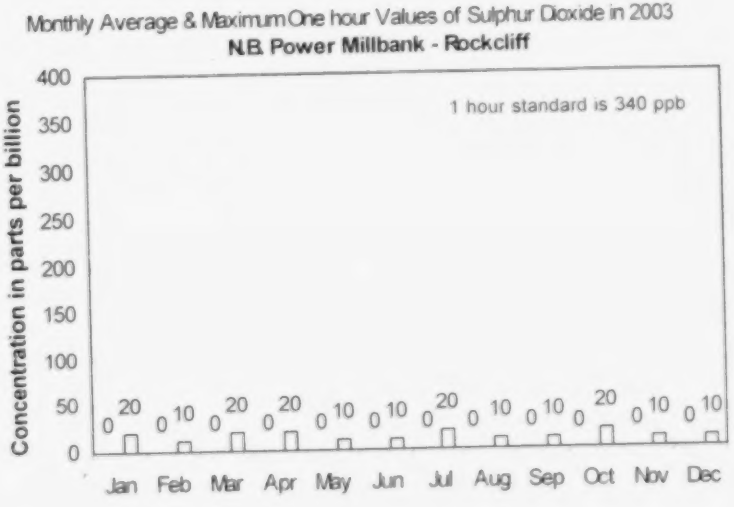
Monthly Average & Maximum One hour Values of Sulphur Dioxide in 2003

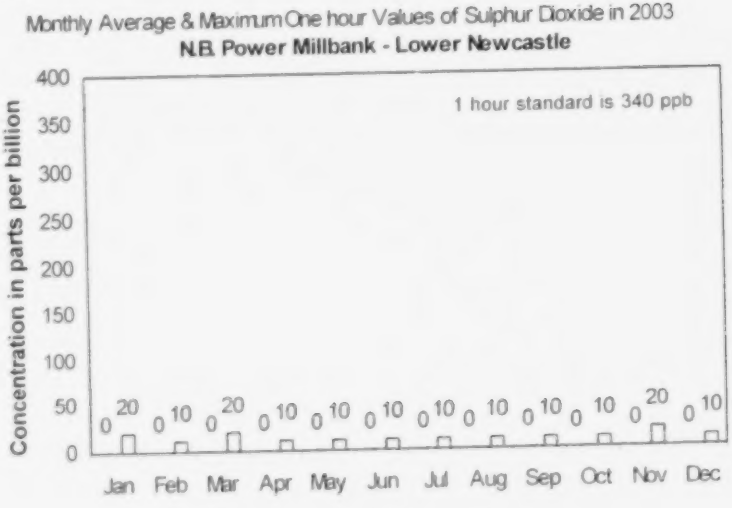
N.B. Power Grand Lake - Cox Point


Concentration in parts per billion
1 hour standard is 340 ppb
400
350
300
250
200
150
100
50
0
10 210 10 230 10 250 10 170 0 110 0 140 0 100 0 280 0 270 0 230 0 250 10 160
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec


Monthly Average & Maximum One hour Values of Sulphur Dioxide in 2003
N.B. Power Grand Lake - Flower's Cove
Concentration in parts per billion
1 hour standard is 340 ppb
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
230 340 290 160 130 240 410 220 240 170 140 260
10 10 0 0 0 10 0 0 0 0 0 10

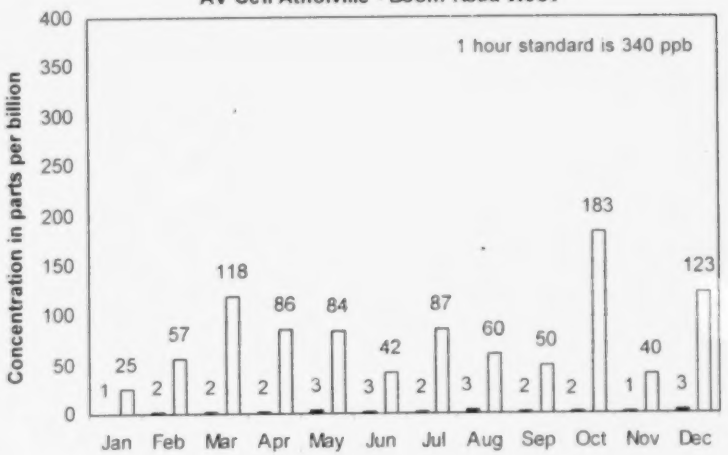

Monthly Average & Maximum One hour Values of Sulphur Dioxide in 2003
N.B. Power Grand Lake - Newcastle Centre
Concentration in parts per billion
1 hour standard is 340 ppb
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
160 240 310 340 230 290 310 360 290 280 350 250
0 0 10 0 0 10 20 10 10 10 10 0


Monthly Average & Maximum One hour Values of Sulphur Dioxide in 2003
N.B. Power Millbank - Rockcliff
Concentration in parts per billion
1 hour standard is 340 ppb
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
0 20 0 10 0 20 0 20 0 10 0 10 0 20 0 10 0 10 0 20 0 10 0 10


Monthly Average & Maximum One hour Values of Sulphur Dioxide in 2003
N.B. Power Millbank - Lower Newcastle
Concentration in parts per billion
1 hour standard is 340 ppb
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
0 20 0 10 0 20 0 10 0 10 0 10 0 10 0 10 0 10 0 10 0 20 0 10

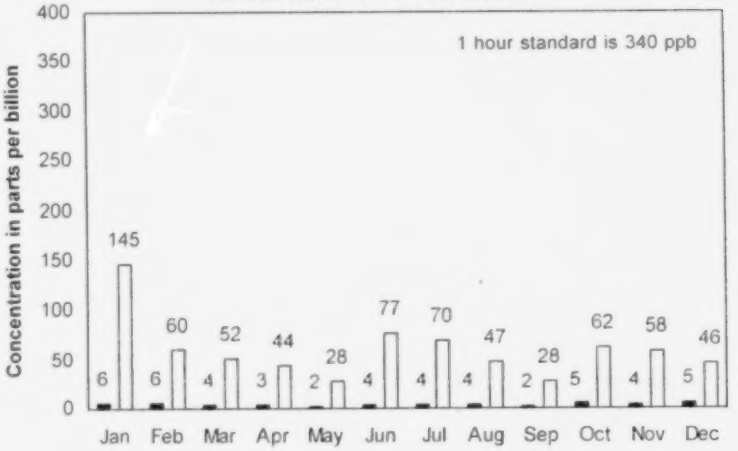
Monthly Average & Maximum One hour Values of Sulphur Dioxide in 2003

AV Cell Atholville - Boom Road West


1 hour standard is 340 ppb
Concentration in parts per billion
400
350
300
250
200
150
100
50
0
1 25 2 57 2 118 2 86 3 84 3 42 2 87 3 60 2 50 2 183 1 40 3 123
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

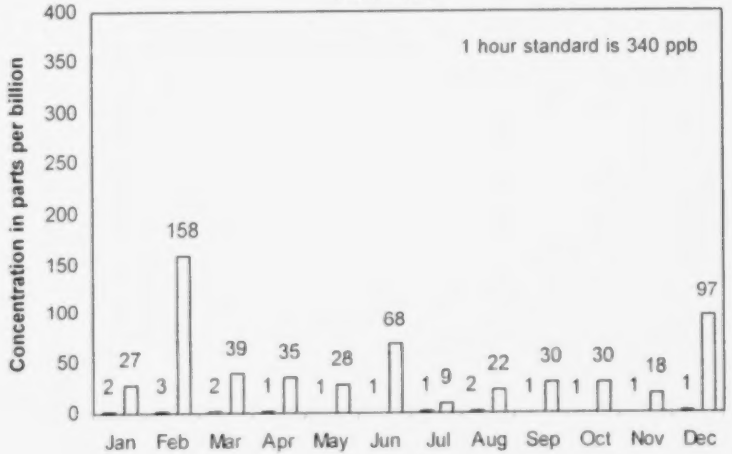
Monthly Average & Maximum One hour Values of Sulphur Dioxide in 2003

AV Cell Atholville - Beauvista East


1 hour standard is 340 ppb
Concentration in parts per billion
400
350
300
250
200
150
100
50
0
6 145 6 60 4 52 3 44 2 28 4 77 4 70 4 47 2 28 5 62 4 58 5 46
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

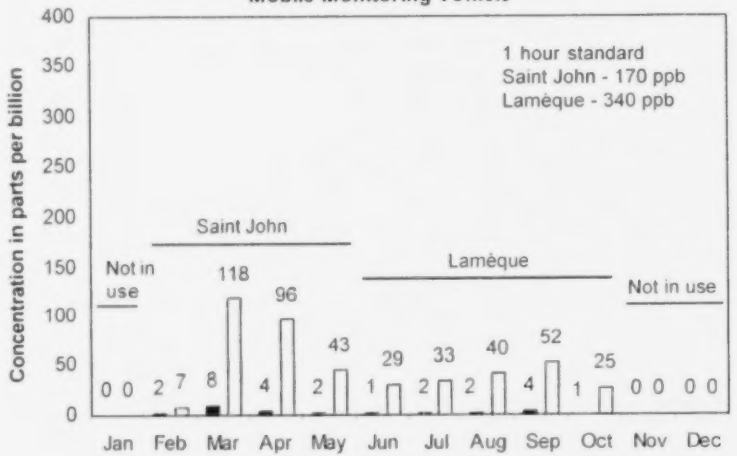
Monthly Average & Maximum One hour Values of Sulphur Dioxide in 2003

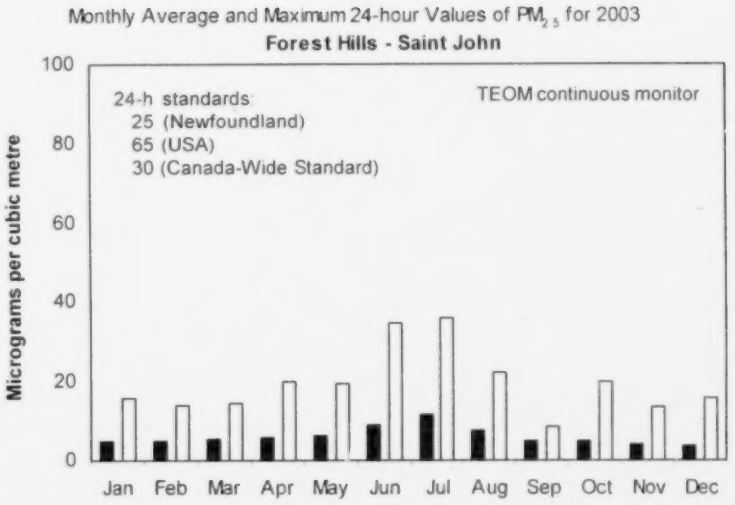
Nackawic

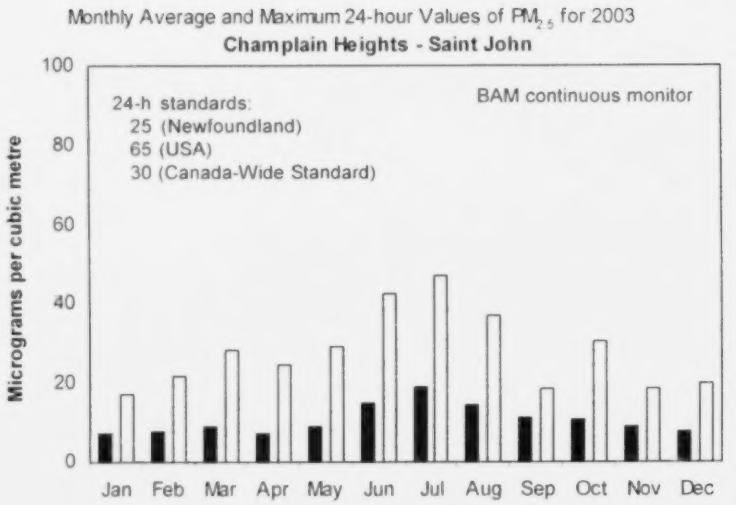

1 hour standard is 340 ppb
Concentration in parts per billion
400
350
300
250
200
150
100
50
0
2 27 3 158 2 39 1 35 1 28 1 68 1 9 2 22 1 30 1 30 1 18 1 97
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

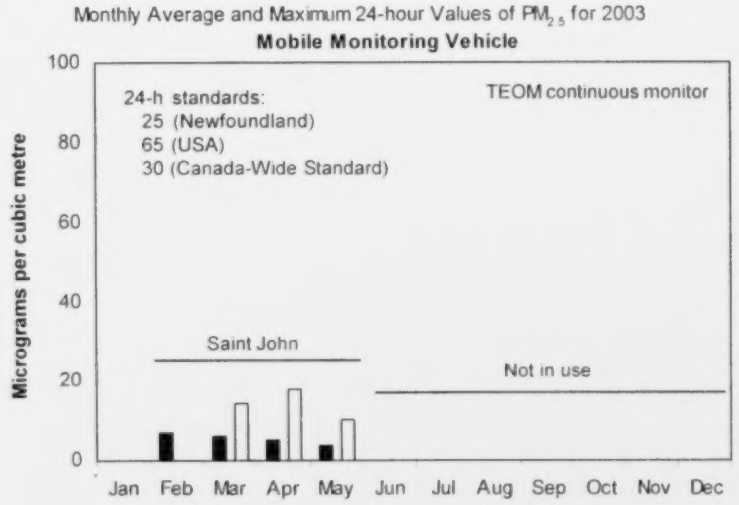
Monthly Average & Maximum One hour Values of Sulphur Dioxide in 2003

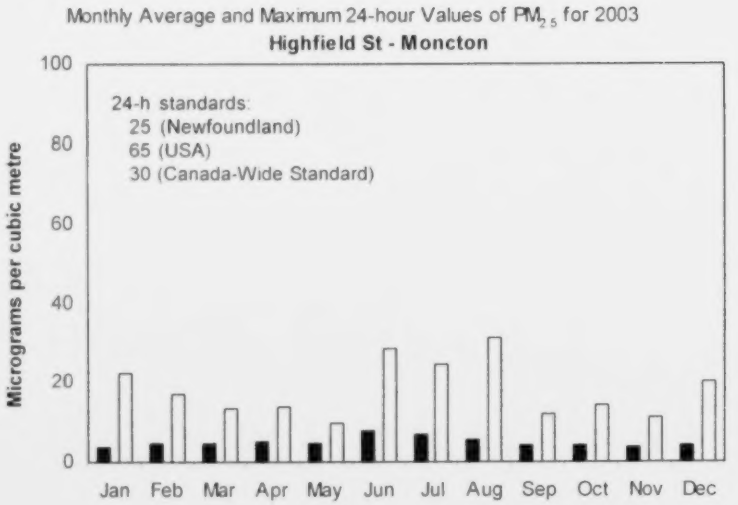
Mobile Monitoring Vehicle




Monthly Average and Maximum 24-hour Values of $PM_{2.5}$ for 2003
Forest Hills - Saint John
TEOM continuous monitor
24-h standards:
25 (Newfoundland)
65 (USA)
30 (Canada-Wide Standard)
Micrograms per cubic metre
0
20
40
60
80
100
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

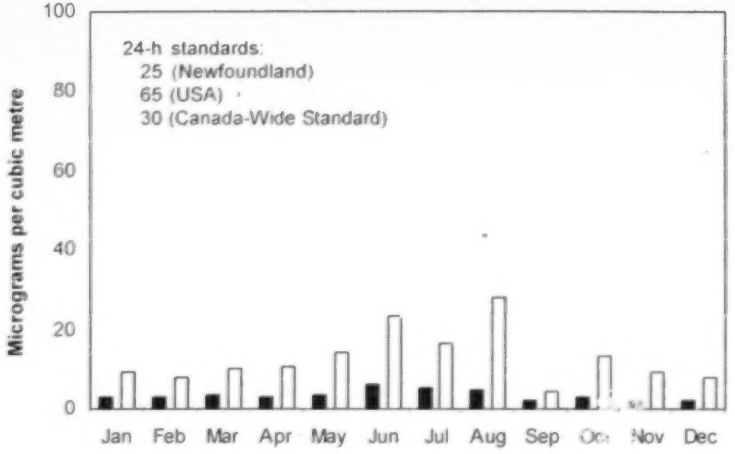

Monthly Average and Maximum 24-hour Values of $PM_{2.5}$ for 2003
Champlain Heights - Saint John
BAM continuous monitor
24-h standards:
25 (Newfoundland)
65 (USA)
30 (Canada-Wide Standard)
Micrograms per cubic metre
0
20
40
60
80
100
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec


Monthly Average and Maximum 24-hour Values of $PM_{2.5}$ for 2003
Mobile Monitoring Vehicle
TEOM continuous monitor
24-h standards:
25 (Newfoundland)
65 (USA)
30 (Canada-Wide Standard)
Saint John
Not in use
Micrograms per cubic metre
0
20
40
60
80
100
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec


Monthly Average and Maximum 24-hour Values of $PM_{2.5}$ for 2003
Highfield St - Moncton
24-h standards:
25 (Newfoundland)
65 (USA)
30 (Canada-Wide Standard)
Micrograms per cubic metre
0
20
40
60
80
100
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

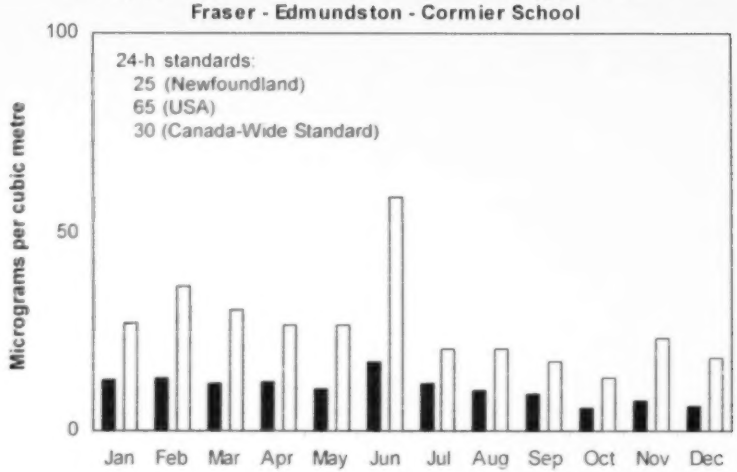
Monthly Average and Maximum 24-hour Values of $PM_{2.5}$ for 2003

HMSC - St Andrews



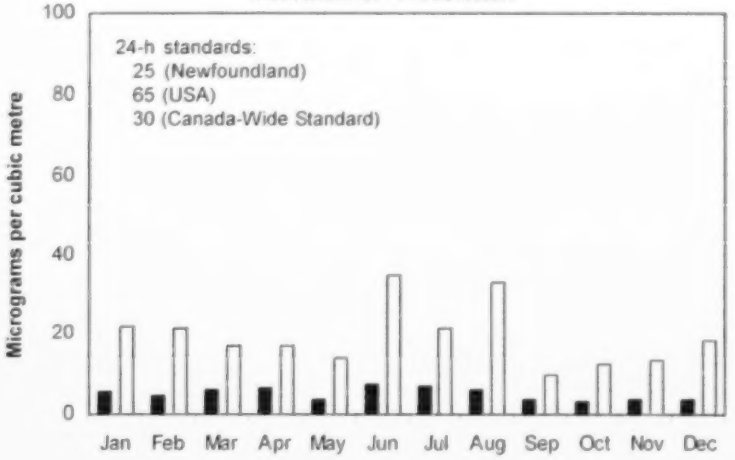
Monthly Average and Maximum 24-hour Values of $PM_{2.5}$ for 2003

Fraser - Edmundston - Cormier School



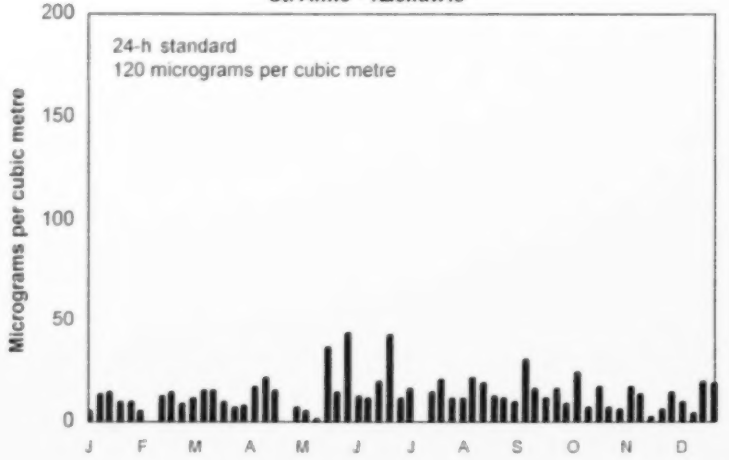
Monthly Average and Maximum 24-hour Values of $PM_{2.5}$ for 2003

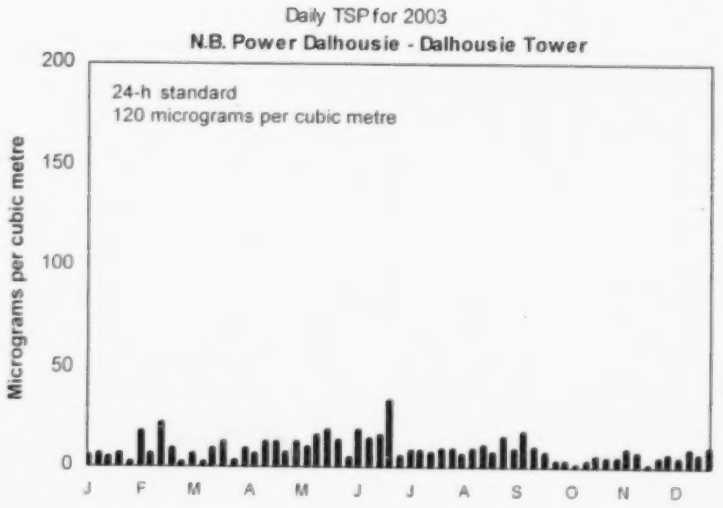
Aberdeen St - Fredericton

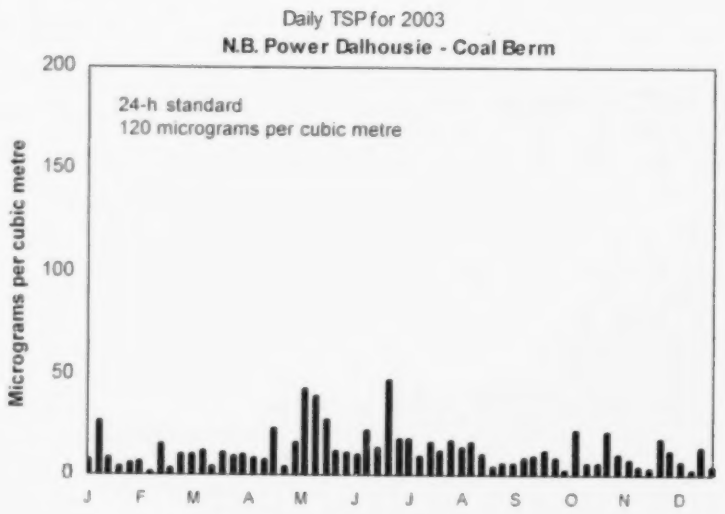


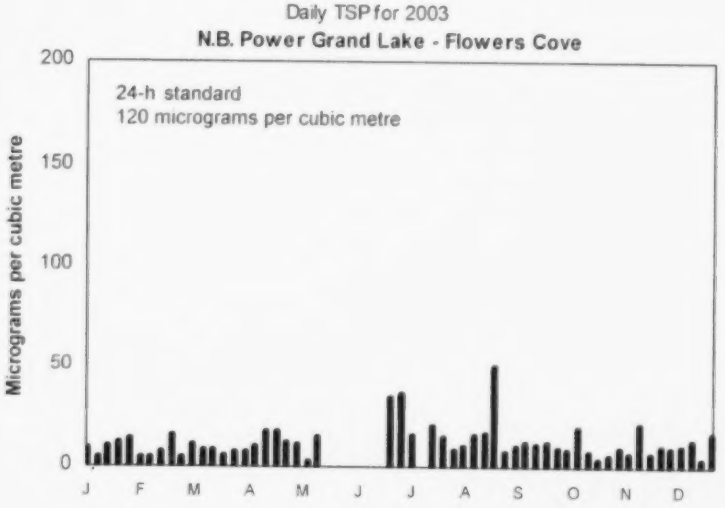
Daily TSP for 2003

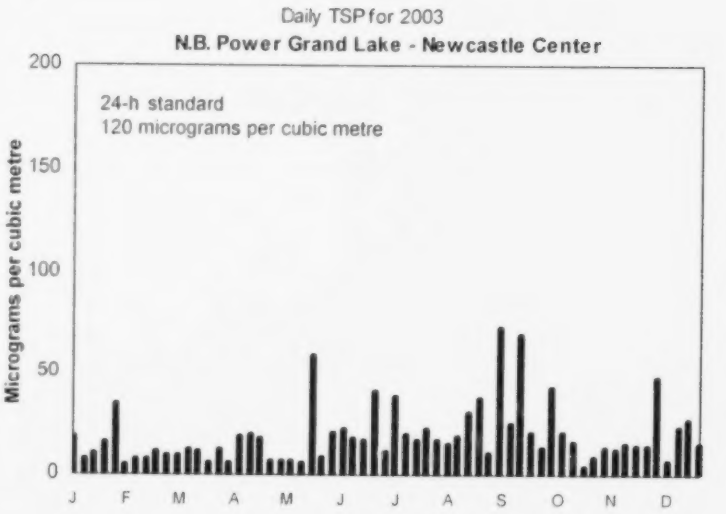
St. Anne - Nackawic

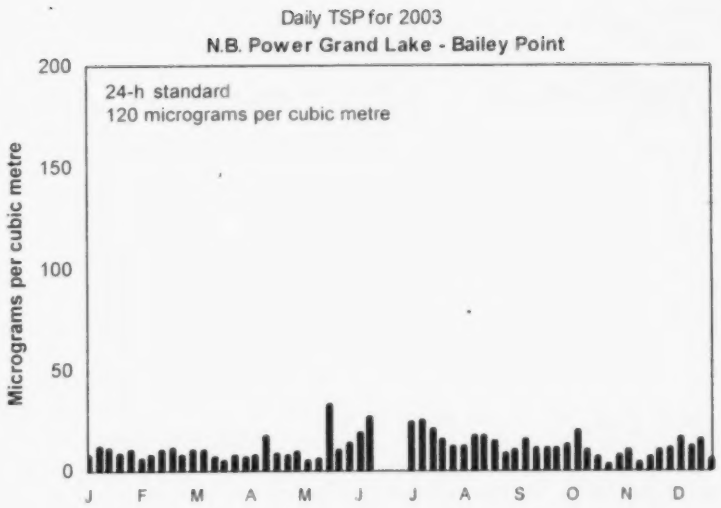


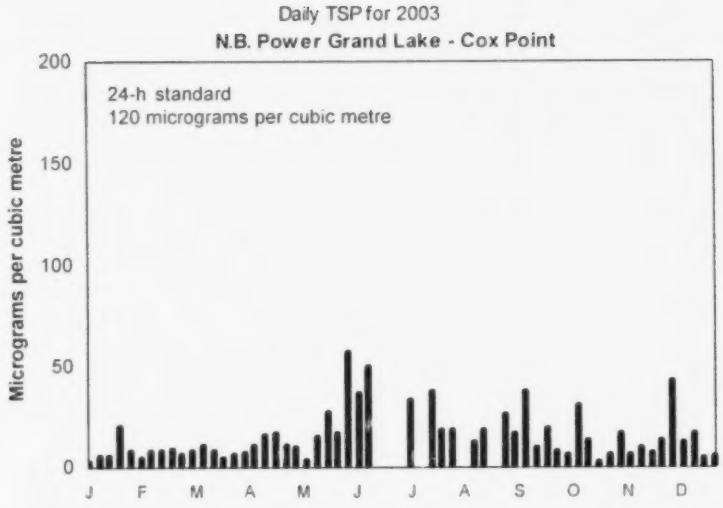

Daily TSP for 2003
N.B. Power Dalhousie - Dalhousie Tower
24-h standard
120 micrograms per cubic metre
Micrograms per cubic metre
200
150
100
50
0
J F M A M J J A S O N D

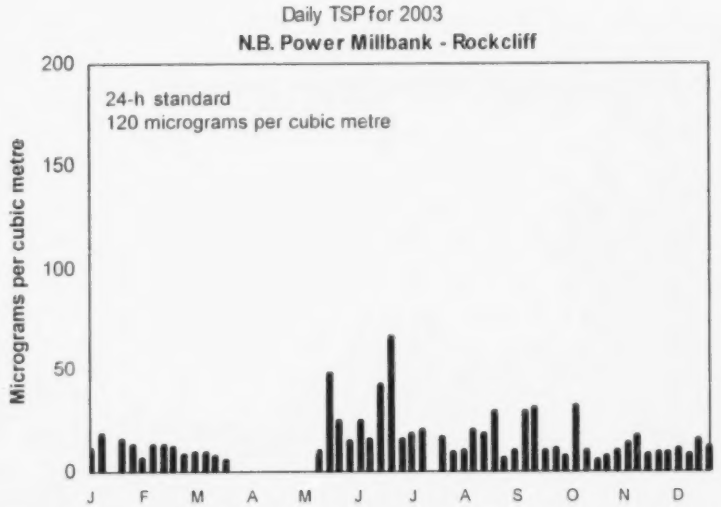

Daily TSP for 2003
N.B. Power Dalhousie - Coal Berm
24-h standard
120 micrograms per cubic metre
Micrograms per cubic metre
200
150
100
50
0
J F M A M J J A S O N D

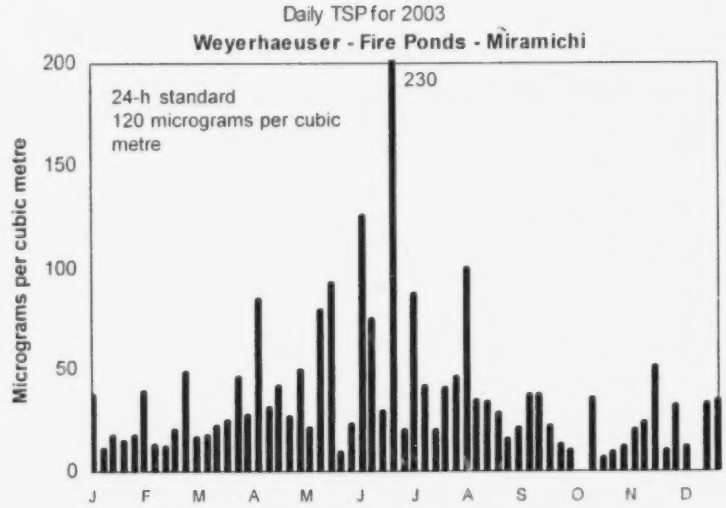

Daily TSP for 2003
N.B. Power Grand Lake - Flowers Cove
24-h standard
120 micrograms per cubic metre
Micrograms per cubic metre
200
150
100
50
0
J F M A M J J A S O N D

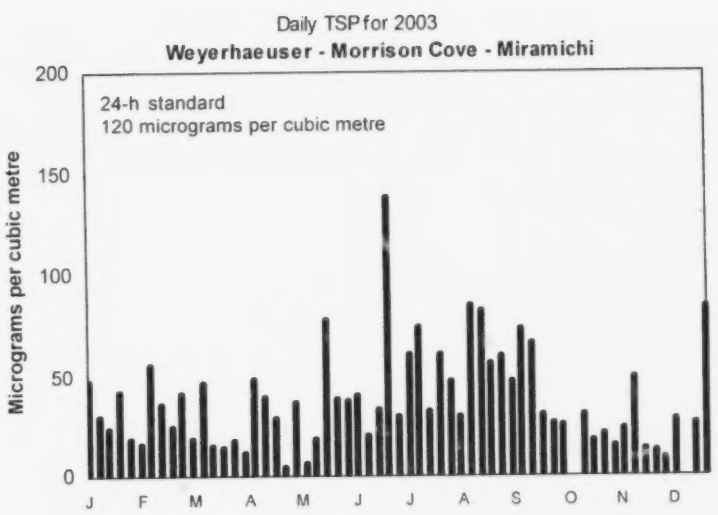

Daily TSP for 2003
N.B. Power Grand Lake - Newcastle Center
24-h standard
120 micrograms per cubic metre
Micrograms per cubic metre
200
150
100
50
0
J F M A M J J A S O N D

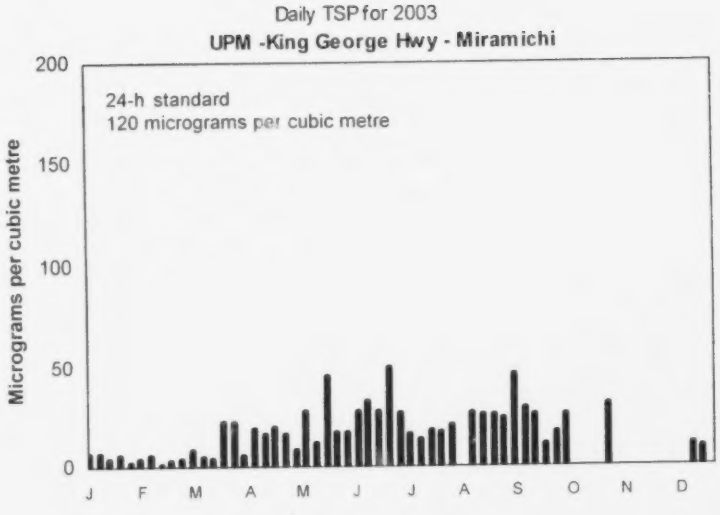

Daily TSP for 2003
N.B. Power Grand Lake - Bailey Point
24-h standard
120 micrograms per cubic metre
Micrograms per cubic metre
200
150
100
50
0
J F M A M J J A S O N D

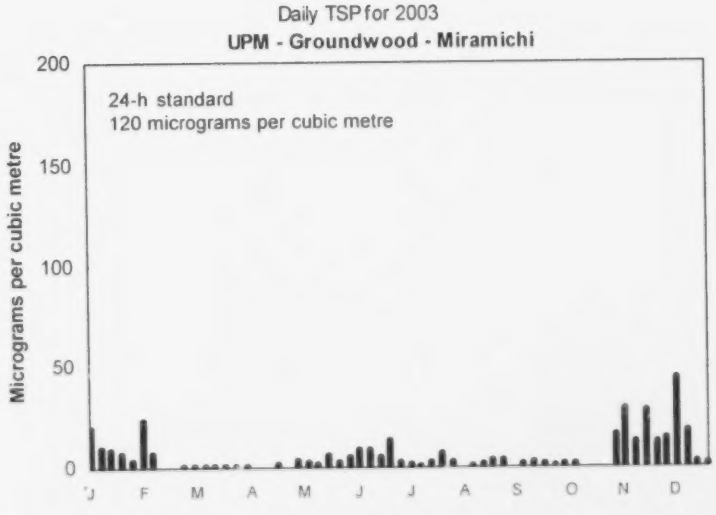

Daily TSP for 2003
N.B. Power Grand Lake - Cox Point
24-h standard
120 micrograms per cubic metre
Micrograms per cubic metre
200
150
100
50
0
J F M A M J J A S O N D

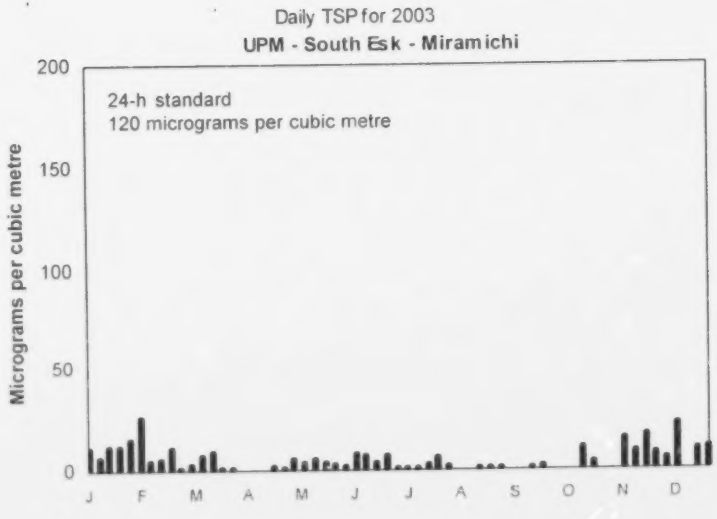

Daily TSP for 2003
N.B. Power Millbank - Rockcliff
24-h standard
120 micrograms per cubic metre
Micrograms per cubic metre
200
150
100
50
0
J F M A M J J A S O N D

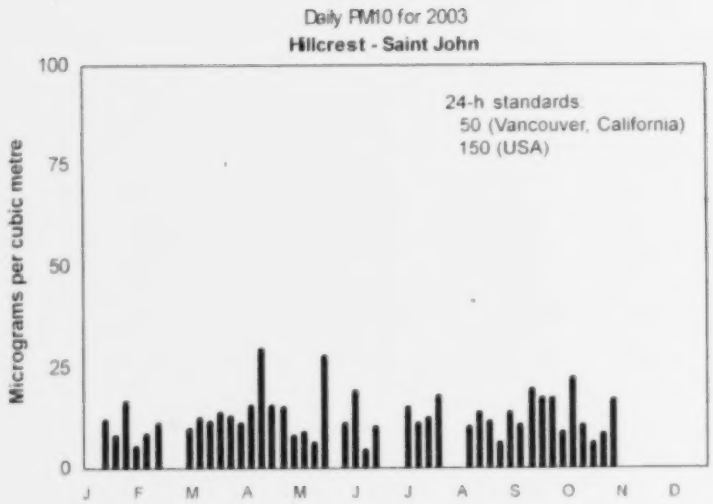

Daily TSP for 2003
Weyerhaeuser - Fire Ponds - Miramichi
24-h standard
120 micrograms per cubic metre
230
Micrograms per cubic metre
200
150
100
50
0
J F M A M J J A S O N D

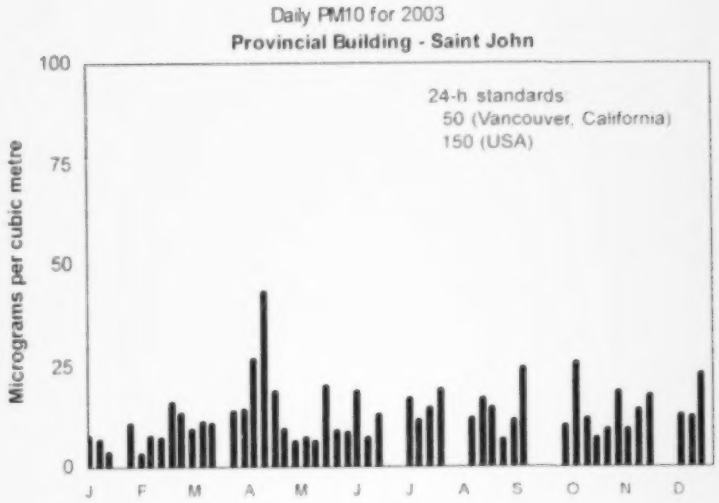

Daily TSP for 2003
Weyerhaeuser - Morrison Cove - Miramichi
24-h standard
120 micrograms per cubic metre
Micrograms per cubic metre
200
150
100
50
0
J F M A M J J A S O N D

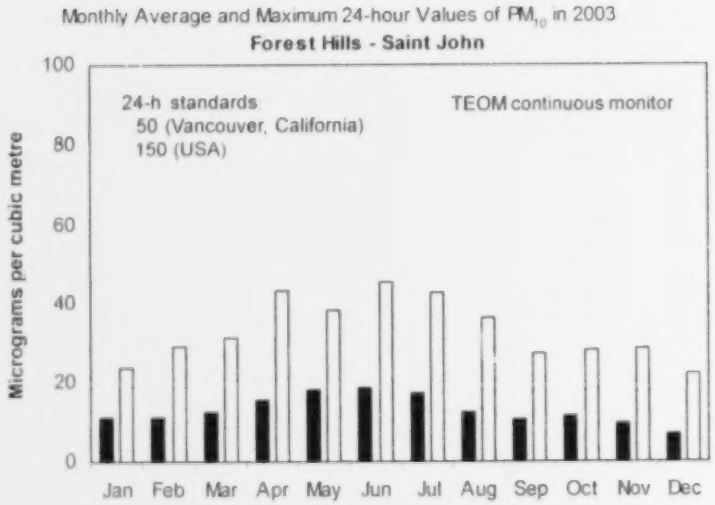

Daily TSP for 2003
UPM -King George Hwy - Miramichi
24-h standard
120 micrograms per cubic metre
Micrograms per cubic metre
200
150
100
50
0
J F M A M J J A S O N D


Daily TSP for 2003
UPM - Groundwood - Miramichi
24-h standard
120 micrograms per cubic metre
Micrograms per cubic metre
200
150
100
50
0
J F M A M J J A S O N D


Daily TSP for 2003
UPM - South Esk - Miramichi
24-h standard
120 micrograms per cubic metre
Micrograms per cubic metre
200
150
100
50
0
J F M A M J J A S O N D


Daily PM10 for 2003
Hillcrest - Saint John
24-h standards
50 (Vancouver, California)
150 (USA)
Micrograms per cubic metre
100
75
50
25
0
J F M A M J J A S O N D


Daily PM10 for 2003
Provincial Building - Saint John
24-h standards
50 (Vancouver, California)
150 (USA)
Micrograms per cubic metre
100
75
50
25
0
J F M A M J J A S O N D


Monthly Average and Maximum 24-hour Values of PM10 in 2003
Forest Hills - Saint John
24-h standards
50 (Vancouver, California)
150 (USA)
TEOM continuous monitor
Micrograms per cubic metre
100
80
60
40
20
0
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

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